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JULY, 1904.

RAILWAY SHOPS.

BY R. H. SOULE.

XV.

CONCLUSIONS:

The Passenger Car Repair Shop. (*Including the Paint Shop and Transfer Table*).—The latest installation is that of the Pennsylvania at Wilmington, Del. The arrangement is the conventional one of two buildings on opposite sides of an intermediate transfer table pit, which is 70 ft. wide; on either side of the pit is a space of 90 ft. wide between edge of pit and adjacent building, making the distance between buildings 250 ft.—rather far, considering the amount of business which must be interchanged between them; each building is 180 ft. wide, and intended to hold two cars to the track. The repair shop stalls can be reached from either side of the building, on one side by ladder tracks and on the opposite side by the transfer table, but the paint shop stall tracks can be reached from the transfer table side only. The capacity of the plant is stated as being 75 coaches repaired per month.

The new Portsmouth, Va., passenger car repair and paint shop of the Seaboard Air Line is a good example of simple, straight-forward design and construction, where local climatic conditions were taken advantage of, and the cost of the building kept down to 68 cents per square ft. The building is 80 ft. wide, with doors at both ends of each stall track, so that trucks can be moved outside the building and repaired, and as above implied, the stalls can be used interchangeably for both repair work and paint work.

The Freight Car Repair Shop and Yard.—There have been some recent examples of improved practice; at Portsmouth, Ohio, the N. & W. have laid out a new double-ended yard with planing mill immediately alongside, and a system of cross tracks for trucking lumber.

The Scranton, Pa., freight car repair plant of the D., L. & W. is, as far as known, the only plant which has been put up for the exclusive work of freight car repairs; a group of eight buildings provides very complete facilities; there are two large buildings, each 150x400, and each building holding 48 cars, for heavy repairs or for construction, while light repairs only have to be done in the open. With such complete and well arranged facilities, and with the entire resources of the plant concentrated on one class of work, very large output results ought to be expected.

The Danville, Ill., plant of the C. & E. I. includes a single-ended freight car repair yard with a standing capacity of about 460 cars when properly separated; there is no provision (other than the coach repair shop) for doing freight repair work under cover; the planing mill is alongside the yard, and the machine and smith shops are not far away.

The Planing Mill. (*Including the Cabinet Shop and Lumber Yard.*)—In rearranging the West Milwaukee plant of the C., M. & St. P., a stream was diverted and the lumber yard rearranged, the result being an extremely ample and convenient yard which is laid out on the general basis which practice has pointed out as the best, although in this particular case the tracks are spaced farther apart than usual.

The Power Plant.—At Moline, Ill., the C., R. I. & P. have put up a power plant in connection with their new shops which has several noteworthy features. The installation includes economizers and induced draft apparatus which naturally go together, but does not include condensers, which arrangement provides for utilizing the waste heat from the boilers, but not that from the engines, but no doubt all the exhaust steam will be used for heating purposes, and possibly water for condensing purposes would have been expensive, as the pumping station supplying the plant is evidently very far away, as there is a rotary converter and a step-up static transformer for furnishing power to it. The induced draft apparatus is housed in a small wing, and there is a second one covering the coal-receiving hopper, a rather unusual arrangement, as the majority of our railway shop power plants are simple rectangles in ground plan outline; the breeching or smoke flue is of brick, a much better permanent arrangement than the usual sheet iron construction, which is liable to corrosion and is apt to cause interruptions of boiler service when renewals are required.

At Wilmington, Del., the power plant of the new P. R. R. shops also has interesting features; a track runs into the boiler room, but at trestle height above the floor; the coal is dumped on the floor and the boilers are hand fired; this arrangement of internal trestle is simple and direct, but is seldom used in the ordinary form of power plant, where the engine room and boiler room are side by side, as it would require the width of the building to be increased; but at Wilmington the two are end to end, and the width of the building was fixed by the engine room requirements, so that the internal boiler room trestle could be used to advantage and without extra cost of building. In this plant the primary generators are alternating, although there is a secondary direct current generator, in addition to an exciter set; there being also a motor generator, a very flexible arrangement results, as, even with the complete disablement of either class of generating machinery, it will still be possible to produce either or both currents in limited quantity. Three separate switchboards are installed, one for local alternating current, one for local direct current, and one for direct current used in the signaling system of the main tracks. The air compressing plant is usually complete, as it supplies air not only for local use at the shops but for the electro-pneumatic switch and signal system as well; there are special after coolers, both air and water, designed by the railroad company and intended to condense and precipitate the greatest possible proportion of the suspended moisture, which is sure to cause trouble if allowed to pass into the service pipes, particularly those of the signal system.

Danville, Ill., on the C. & E. I., affords another example of recent power plant practice; here, on account of coal being cheap and water comparatively dear, compound cylinders and condensers were eliminated, and only simple engines are found; moreover, so much confidence is felt in the generating apparatus that no spare units are provided, although the power actually installed is in two units; direct current is used throughout, power being distributed on the two-wire system and lighting current on the three-wire. Here is also found the only known extensive application (in railway shop power plant practice) of the double commutator system of motor speed control; those motors which are to be worked at variable speeds have two distinct armature windings, each connected to its own commutator, and obviously these windings can be so proportioned as to give any desired speed ratios (within limits) when used either one singly, the other singly, or the two together. In practice these combinations are effected through a controller which may be placed conveniently to the tool operator, and which is arranged to switch in and out such varying amounts of field resistance as may be required to secure the necessary intermediate steps of motor speed. In this particular application each controller is also equipped with automatic cut-outs for overloads and no load, so that the motor mechanism is well protected; it is quite possible that this and perhaps other installations of the double commutator system of motor speed control may make it necessary to revise the opinion previously expressed that the system was too complicated.

The Storehouse.—It is stated that the new storehouse of the Seaboard Air Line, at Portsmouth, Va., is one of the largest in

the South; it is 70 ft. by 225 ft. and two stories; it has ample platforms, which are supported by earth filling, now planked over, but later, when renewal is necessary, to be cemented; the walls up to the level of the first floor window sills are of brick, but above that are corrugated galvanized iron on wooden framing; the roof is gravel; the whole making a very satisfactory, and also a very cheap, building.

At Wilmington the storehouse and office are combined, but at Danville they are separate.

The Foundry.—A recognized authority on foundry practice has recently stated that the best arrangement for taking cupola supplies up to the charging platform was a single hydraulic lift for plants turning out not over 50 tons of castings per day, and a double, balanced, steam or electric elevator for plants of greater output. A recent improvement in foundry equipment is the centrifugal sand mixer, electric driven, which yields an output as high as 5 tons per hour; ordinarily, however, this would be used only where a better grade of castings was required.

The Roundhouse.—An examination of the new roundhouse of the Pennsylvania at Wilmington, Del., will disclose several noteworthy features; the span, out to out of walls, is close to 90 ft., which is equal to the maximum of those previously listed; this dimension is so liberal, and the chances of any considerable increase in the over-all length of locomotives is so remote, that it is likely to remain a maximum for some time to come, although the justification for it is so complete that it is probable that it will become almost standard for the future. The turntable diameter is 75 ft. as against the maximum of 80 ft. at three B. & O. points previously listed; this is one of the lightest roundhouses yet built; others have had as high outer walls, but none have had as large a percentage of window openings; the provision of a traveling crane runway in the outer circle is the first case in railroad practice, but was probably based on the precedent established by the Baldwin Locomotive Works in their new Twenty-seventh street (Philadelphia) roundhouse. In this case smoke jacks are dispensed with and a continuous slatted ventilator in the peak is substituted, but patented systems have been devised by which traveling cranes and smoke jacks may be used in combination; the smoke jack, being both telescopic and jointed, may be drawn up and swung out of the way to allow the crane to pass. The feature of greatest novelty, however, is the provision of two inspection pits on the tracks approaching the ash pits, each of these pits being 80 ft. long; they are about 4 ft. deep, properly drained and lighted (electrically) and are entered from either side, at the center, by transverse steps formed in concrete; the idea is that proper and thorough inspection can be made while the engineman is present, and necessary repair work anticipated and arranged for while the engine is on the ash pit: in some cases it will happen that no work is required, and in such cases the engine, if business is pressing and power is in demand, may be supplied with coal and water, turned, and started out again, without entering the roundhouse at all.

At Danville the new C. & E. I. roundhouse has an out to out span of over 85 ft.; but in this case a low flat roof, supported by circular cast iron columns is used; the house is heated by the fan system and well lighted electrically; the turntable is 75 ft. diameter.

The Layout.—The original article having been published in the May issue, there is little to add, but a comparison of the layouts at Wilmington and Danville is instructive. At Wilmington the shop buildings are grouped as a unit or complete plant, while the roundhouse is isolated, being perhaps 1,200 ft. (on the average) from the departments with which it has intimate relations, as, for instance, the storehouse, erecting, machine, boiler, and smith shops; the roundhouse has a few machine tools as an offset to this. At Danville, on the other hand, the roundhouse is the centre of the group, the other departments (above listed) being ranged approximately in a circle about, and equidistant from it; the car shop buildings, the power plant, and the planing mill, being given locations farther away.

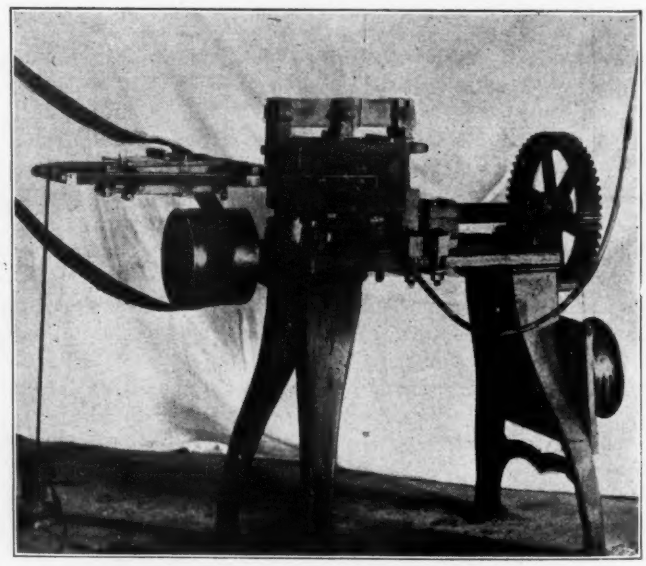
General.—It is noticed that shop buildings are sometimes figured to even feet in their outside dimensions, and sometimes to even feet in their inside dimensions, in which latter case the outside dimensions will almost always involve inches, and in many cases fractions of inches. As a problem of shop design always begins with the layout, and as the ground areas covered by the several buildings are essential factors in the problem all through, there is every reason why even feet outside dimensions should be used; when the cross sections are taken up it is just as convenient to start with an even outside as with an even inside span; in some cases neither the outside nor the inside dimensions can be expressed without resort to inches and fractions, and it is probable that in such cases the structural engineer has taken even feet for his roof span, making all other principal dimensions come out uneven. But this is a final plea for the uniform use of even feet outside dimensions.

TEST OF THE EFFECT OF INCREASING BOILER PRESSURE ON THE LIFE OF A STAY-BOLT.*

BY MILTON J. PHILLIPS.

As the stay-bolt is one of the weak parts of the modern locomotive boiler, and as much fear has been entertained by designers on the effect of increasing boiler pressures on the life of the stay-bolts, a test was made to show the effect of increasing boiler pressure.

With varying boiler pressures we have only one variable, as it is common practice to give stay-bolts a constant load per square inch at root of the threads, irrespective of boiler pressure, thus the only variable is the temperature, which varies with the boiler pressure. It is a well-known fact that stay-bolts do not fail in tension, but that they fail due to bending caused by the travel of the fire-sheet of the locomotive boiler



PHOTOGRAPH OF TESTING MACHINE SHOWING OIL BOX AND MECHANISM.

relative to the outer sheet or shell. That these sheets have a relative movement was shown by a series of experiments conducted on the Western Railway of France in 1894, and reported in the AMERICAN ENGINEER AND RAILROAD JOURNAL, 1894, page 114; also in the same journal in 1897, page 319, is a report upon the same subject, which says that most of the broken bolts are found on the curved portions of side sheets and at the corners where the movement is greatest.

Though stay-bolts have been given only a load of from 5,000 to 6,000 lbs. per square inch, giving them a factor of safety of from 8 to 10, it has come to be recognized for some time past that the tensile test is but a poor test, and that some form of bending test is better. Several tests of this kind are in use, as, for example, the doubling test of the Baldwin Locomotive Works and the vibrating test of the Pennsylvania Railroad, where one end of the bolt is held rigid and the other

* Thesis text, Sibley College, Cornell University, Ithaca, N. Y.

moved back and forth ⅛ in. off center until fracture occurs. Thus the only thing to be done to ascertain the effect of increasing boiler pressures on the life of stay-bolts was to build a machine to duplicate as far as possible actual conditions and vary the temperature.

LOG OF STAYBOLT TEST.

Test. No.	Boiler Pressure, Lbs. Per Sq. In.	Temperature, Degrees F.	Vibrations.
1	150	365.5	2,760
1a	150	365.5	3,389
2	175	377.1	2,860
2b	175	377.1	2,205
3	200	387.5	2,900
4	225	397.0	2,949
5	300	421.7	3,778
6	350	436.3	3,933

1a was about 1-16 in. long.
2b was about ⅛ in. short.

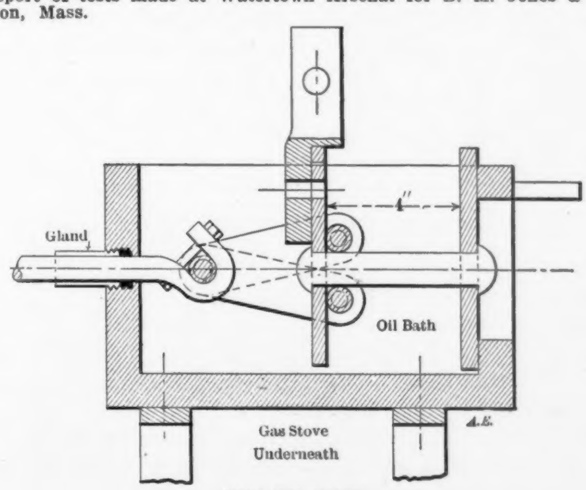
TENSILE TEST OF BOLTS.

Specimen.	Diam. in Inches.	Sectional Area	Ultimate Strength Total Lbs.	Ultimate Strength Lbs. Per Sq. In.	Elongation in 2 Inches.	Elongation in 2 Per Cent.
1	.5764	.2604	15,300	58,800	.71	35.5
2	.6	.2827	15,690	55,500	.72	36.1

TENSILE TESTS OF TAYLOR IRON ROUND BARS, 30 INS. LONG.

Diameter in Inches.	Section at Area Sq. In.	Elastic Limit Total Lbs.	Elastic Limit Lbs. per Sq. In.	Ultimate Strength Total Lbs.	Ultimate Strength Lbs. per Sq. In.	Elongation in 10 In. per cent.	Appearance of Fracture
1.00	.785	25,070	31,940	42,710	54,410	31.7	Fibrous
1.01	.801	28,580	35,680	42,250	52,750	29.7	Fibrous
.93	.679	23,700	34,900	36,160	53,250	31.3	Fibrous

Report of tests made at Watertown Arsenal for B. M. Jones & Co., Boston, Mass.



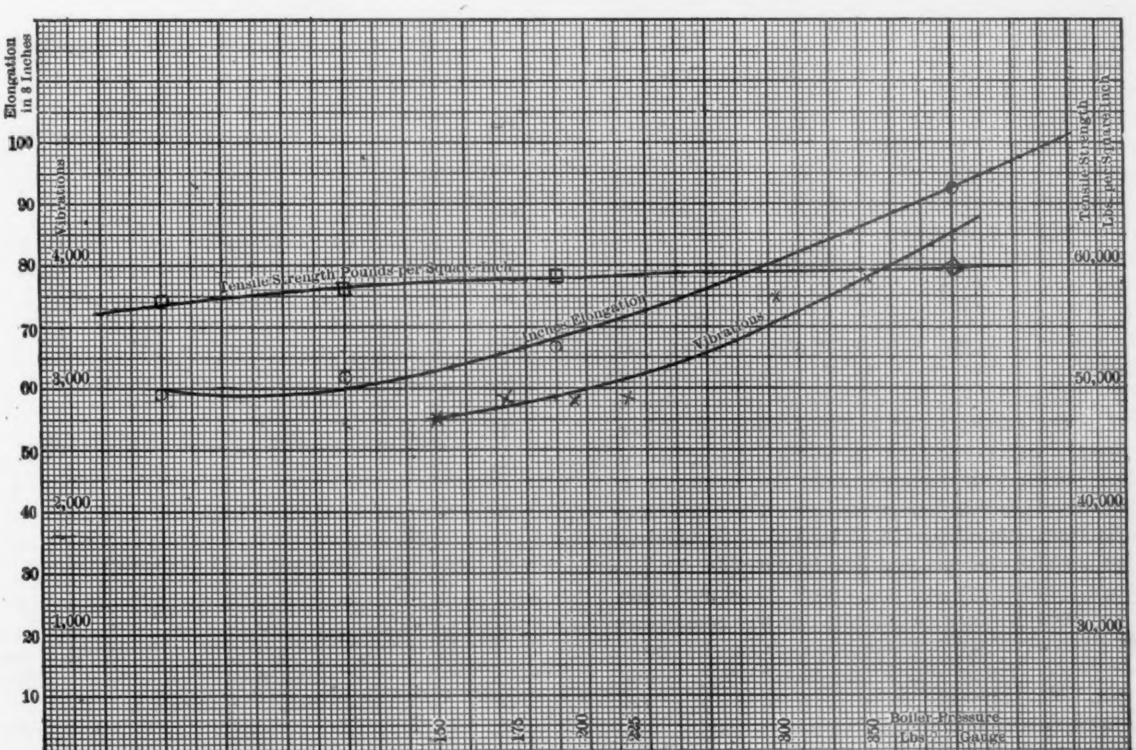
THE OIL BATH.

The conditions to duplicate were to hold the stay-bolt in boiler plate, outer plate thicker than inner, stay-bolt to be subjected to constant tensile load, inner plate to move relative to outer plate; outer plate to be fairly rigid; inner plate to be as free to bend as it is when hot, and to provide two further conditions of the machine, namely, the bolt to be held in the same manner each time, with the same rigidity, and the bolt to bend in the same way relative to the piling of the iron. Of course, these last two conditions are not met in actual practice, but had to be maintained to make but one variable for the test.

The above conditions were maintained in the machine used. The outer plate was bolted over a 4 x 4-in. hole in the end of the box. The outer plate was ½-in. plate, while the inner was ⅜-in. boiler plate, having been furnished by Burnham, Williams & Co. A constant tensile load was applied by means of a spring dynamometer, which acted on a rod coming through the stuffing box in the end of the box and attached to rods with roller bearings on the water side of the inner plate. The rolls gave the inner plate freedom of motion up and down. The dynamometer load was adjusted by means of two ½-in. bolts in the end of the dynamometer frame. The inner plate was moved relative to the outer plate by means of an eccentric on a shaft which lifted and lowered a lever, the movement of the plate being ⅛-in. off center each way. This was more than is found in actual service except in extreme cases, but had to be large to reduce the time of test within commercial limits. The inner plate was free to bend under the strains given, yet was rigid in directions in which rigidity is required.

The bolts were 1 in. in diameter, of the best "Taylor" iron, furnished by B. M. Jones & Co., of Boston, Mass. The ends of the bolts were etched and they were found to be of slab piled iron, as is shown by the prints taken from some of the etchings. According to Paul Krenzpointner, of Altoona, a bolt tested with the pile will stand several hundred more vibrations

ETCHED SECTIONS OF STAY-BOLTS.



CURVES SHOWING COMPARATIVE RESULTS.

than one against the pile. Thus, to make the test constant in that respect, all bolts were etched and then tested with the pile. Great care was taken also to have 7-16 in. of the bolt to rivet over and to make good, even heads. The number of vibrations was obtained by means of a revolution counter, attached to the main gear. In conjunction with this there was an automatic belt shifter that operated when the bolt broke. When the bolt broke the dynamometer drew the connection bar out until it disconnected a dog which allowed a gravity belt shifter to throw off the belt. The temperatures were obtained by means of a bath of cylinder oil and a gas stove. The inside of the outer sheet, the bolt, and both sides of the inner sheet, were exposed to boiler temperature, as in the locomotive boiler, while the outer sheet was exposed to the atmosphere on the outside. To keep the temperature constant, and to collect the fumes from the oil, a hood of tin was placed over the whole machine.

The constant tensile load was 3,200, or 200 lbs. per square inch on 16 sq. ins., an average of a large number of existing designs examined. The curve of vibrations shows an increase of from 2,760 vibrations at 150 lbs. pressure to 3,933 at 350 lbs. This curve is compared with one made on ductility at different temperatures by O. R. Wilson and R. L. Gordon for a thesis and reported on to the American Society of Mechanical Engineers in December, 1895, by Prof. R. C. Carpenter. Both curves show the temperatures corresponding to various boiler pressures to be beyond the point of minimum ductility or the blue heat danger point, as it is commonly called.

While the length of the stay-bolt was supposed to be kept constant, in two cases it was allowed to vary, and it showed that the length played a very important part in the life of the stay-bolt. That this is so may be seen from a record of two similar boilers in the AMERICAN ENGINEER AND RAILROAD JOURNAL, December, 1899, where one had a 3½-in. water leg and a record of 236 broken stay-bolts in six months, while the other, with a 4½-in. water leg, had only 32 broken. This is probably due to the fact that the movement of a 4-in. bolt even 1-32 in. off center would strain the metal in the outer fiber beyond the elastic limit, yet even beyond the ultimate fiber stress. This is shown by an application of the cantilever formula, as found in Unwin. The application of this formula shows how a small deflection may strain the outer fiber of a bolt beyond the elastic limit or beyond the ultimate strength. This may account for the results given by Mr. Spencer Otis in the discussion of a stay-bolt test of Francis J. Cole before the American Society of Mechanical Engineers in June, 1888. Mr. Otis said: "Ordinary tests give very little indication as to how a given iron will stand vibration; for instance, the average of some twenty tests of two irons is as follows:

	Tensile.	Elongation, Inches.	Elastic Limit.	Vibrations with 1,000 lbs. Tension.
No. 1	52,000	25%	26,600	89,170
No. 2	51,400	28%	26,210	37,470

While the No. 1 had much less ductility, its tensile strength was greater, thus the outer fiber was not strained so much beyond the ultimate limit."

While the above test has shown the groundlessness of the fear of higher boiler pressures, and temperatures corresponding as to blue heat effects, it has accidentally shown us that great care should be taken in getting as great a length of stay-bolt as possible. The computations also show the need of some form of ball and socket head in the places of greatest movement. In fact, the test has shown us the reason for hope of better stay-bolt life with higher boiler pressures.

CORRESPONDENCE.

SIMPLE METHOD OF ADJUSTED TONNAGE RATING.

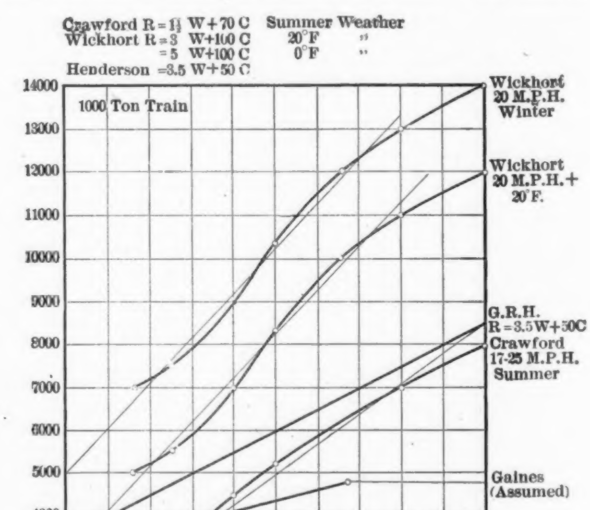
To the Editor:

I have been very much interested lately in matters relating to adjusted tonnage rating, and have read once more Mr. Wickhorst's admirable paper before the Western Railway Club on this subject, and the discussion it gave rise to. In that discussion Messrs. Gaines and Henderson both referred to their experience as to the tractive power required for light and loaded cars, and Mr. Henderson gave as his experience an especially simple formula, R = 3.5 W + 50 C, and also referred to a chart he had designed to enable the results of this formula to be practically applied. In looking into the matter more carefully it will be noticed that Mr. Henderson's formula does not agree with the results obtained by Mr. Wickhorst and Mr. Crawford on the Pennsylvania lines.

To illustrate this I have plotted the resistance on the level of a 1,000-ton train of from 10 to 100 cars, to show the relation between the resistance and the number of cars on the train. It will be remembered that Mr. Wickhorst gave a curve (Mr. Crawford's), which he called the P. R. R. curve for summer weather, a curve obtained from his dynamometer car records, which represented the resistance at a temperature of 20 deg. F., and an arbitrary curve obtained by adding 2 pounds per ton to the latter, which was assumed to be the resistance at 0 deg. F. These curves, plotted as mentioned above, are each shown on the diagram, and I have also shown a line derived from Mr. Gaines' statements, but this line is probably not correct, owing to Mr. Gaines not having stated the grade resistance in his experiments. Now, while none of the results are exactly straight lines, they are practically so within the limits of 20 and 70 cars per train, which are those which would obtain in service. The straight lines corresponding to the various curves between these limits are shown by dotted lines in the diagram, and these lines can be expressed as follows, if R = resistance in pounds; W = weight of train in tons; C = number of cars in train:

Crawford, summer weather, R = 1½ W + 70 C.
Wickhorst, 20 deg. F., R = 3 W + 100 C.
Wickhorst, 0 deg. F., R = 5 W + 100 C.
Henderson, R = 3.5 W + 50 C.

It would appear as if Mr. Henderson's allowance per car was rather too low, but the important result remains that the resistance can be expressed in this manner, and if it be assumed that Mr. Wickhorst's results can be accepted, or for that matter



COMPARISON OF METHODS.

any of these results, then I cannot see why a chart is necessary at all. It must be remembered that on any grade of g per cent, the formula would become:

$R = (3 + 2g)\ W + 100\ C.$

Now let $W_1\ (3 + 2g) = R;$

Then $W_1\ (3 + 2g) = W\ (3 + 2g) + 100\ C;$

$$\text{Or, } W = W_1 - \frac{100}{3 + 2g} C.$$

In other words, if W be an arbitrary rating, then all that it is necessary to do to obtain the equivalent tonnage is to subtract 2, 3, or 4 tons per car from this rating. This figure could easily be established for any division. For instance, suppose g to be I per cent. Then $2g + 3 = 23$ and $\frac{100}{23} = 4$ 1-3 tons, say 4 tons.

Now if for any engine the arbitrary rating were established at 950 tons, then for a 20-car train the rating would be 950 — 80 = 870 tons; for a 40-car train it would be 950 — 160 = 790 tons, and so on. It appears to me that this method is far simpler tnan the use of any chart, and that once the principle of equivalent tonnage is established on any road there is no objection to the use of an arbitrary rating. I should be very much obliged to some of your readers who are interested in this subject if they would correct me if I am wrong in these statements, as, unless I am, it appears to me that the formula proposed by Mr. Henderson will allow of a very simple method of obtaining the equivalent tonnage being used, if utilized as I have outlined.

H. H. VAUGHAN,
Superintendent of Motive Power,
Canadian Pacific Railway.

SUGGESTIONS CONCERNING "SUCCESS."

To the Editor:

Many of those who have relied for advancement upon suggestions similar to those of "Retired" in your April issue have been disappointed, and I would like to add the following as bearing on questions on which young men are doubtful at some time in their careers:

Keep constantly in mind your intention to take advantage of every opportunity to learn by observation and by thinking. If your employer wishes to advance you, he will be glad to have the quantity of your work suffer to a reasonable extent in your efforts to learn.

Be ready to work overtime cheerfully in emergencies; do not jump for your hat as soon as the clock indicates the hour of closing, and do your best while at work, whatever your salary may be. But your employer is the customer for your services, and habitual overtime work is as uncalled for as the delivery of two pounds of sugar when but one is ordered. What further effort you are capable of making would best be spent in study and reading to prepare yourself to handle in an efficient, up-to-date manner the problems that you hope soon to have presented to you.

If employed in office work, do not neglect out-of-door exercise. Few who have not tried it realize the severity of continued mental work combined with confinement in an office. When possible, office work should have outdoor work alternated with it. Indulge in judicious relaxation. If at all troubled with sleeplessness, ascertain the cause at once; and if the cause is severe mental exertion just before retiring, reduce or regulate your work so that the hour for retiring finds the emotions calm, though the brain may be tired. Health is an important factor of prosperity as well as of enjoyment, and should be cultivated at any cost.

Do not assume that, because you are strenuously complying with all your duties to your employer, you can leave all your interests to his care. In your dealings with him govern yourself by that independent, cautious, self-reliant judgment which he would want you to employ if you were to represent him in dealings with a third party. Consult freely, but decide for yourself. Some employers would think you "easy" if you acted otherwise, and none can find fault with such a course.

Have a distinct understanding as to what are your duties and responsibilities. Perform your duties conscientiously, and leave others to perform theirs. As your position becomes more important, it is well to have your duties specified in writing.

Transact all business with the proper authority. Work heartily in the interests of your immediate foreman, and do not solicit the favor of, or have direct business intercourse with, his superior without his knowledge and approval. Do not allow the superior to slight your foreman in any way in his dealings with you. In other shops and offices where you may have business always transact it with the foreman, unless you are sure he wants you, in any particular instance, to deal directly with his men. You may occasionally have to decide between the conduct which will advance you most and that which is most creditable.

Be extremely cautious about criticising other men employed by the same company as yourself. Govern yourself by a sincere and far-seeing desire to help your fellow-employees, to do no injustice, and to avoid needless entanglements. Assume that your words will have a "large circulation" and will reach the person criticised.

Study your superior officers. No two are alike, and the most careful watchfulness may fail to reveal to you their ideals of a good employee. Some officers may think that a few of these suggestions, as well as some of those of "Retired," should be ignored. One foreman may think that your attitude toward work should exhibit certain characteristics, and you may by watchfulness modify your inclinations so as to satisfy him. Presently a change places you under a foreman who prefers the opposite characteristics, but you may never know of his displeasure unless you hear of it indirectly after a conference in which your promotion was discussed.

Take a kindly interest in the men about you and greet them cordially on meeting them, but avoid anything resembling intimacy with any for whom you are responsible or with those who have authority over you.

What is "executive ability"? How does it manifest itself? How can it be acquired? Must it be "born in one"? Your employer's views on this subject are important to you.

Though ambition for positions of prominence is laudable, and though by far the greatest factor in the attainment of such positions is individual effort, in your relations with other men bear in mind the fact that position is not a measure of worth, and that many successful lives have been lived in comparative obscurity.

OBSERVER.

APPRENTICESHIP ON AMERICAN RAILROADS.

To the Editor:

I have been greatly interested in your consistent and systematic efforts to place this subject before your readers. I firmly believe that nothing more important than this confronts the officials of American railroads to-day. In this connection, the London editorial in your issue for May, relating to the apprentice schools which have developed in English railway practice, is an exceedingly interesting matter and presented interestingly. It may be made more so if the editor, from this basis, outlines a system of apprentice education for railroads, especially adapted to the mechanical departments here at home. It appears from the statements made of the situation abroad that the average establishments there have provided as favorable conditions for apprentices as are consistent with the practical working of shops.

The writer holds that the best experience and development are possible only in connection with education hand in hand with shop practice in regular apprentice systems, and that in America the railway apprentice might be, and should be, given equally favorable opportunities for education as those you describe abroad. If at the close of the apprentice term any have developed marked ability, their graduation certificate should show this to be the case; and these may be given opportunity to follow up their education by a course in technical schools or colleges.

Professor Goss has given us an insight into some of the difficulties experienced by college graduates in their progress through shops and beyond the shops. In the other system of "Shop and Education" first this difficulty is removed and the man enters college with far greater freedom and chances for success for the man and usefulness for the railroad.

What perhaps is most useful is the educational influence on the workman generally, and as a mass. With a fair education the average American workman will take good care of himself and influence his fellows for good as he advances in the scale of official life which is open to him. GEORGE W. CUSHING.

WHY A YOUNG TECHNICAL MAN LEAVES RAILROAD SERVICE.

EDITOR'S NOTE.—The following is quoted from a letter received from a young technical graduate who has spent a number of years in railroad work, where he rose to the position of foreman. It is printed without comment because no comment seems necessary:

To the Editor:

I did not leave railroad service without considerable study and

thought on the subject, and finally came to the conclusion that there was not enough in railroad work to make it pay. In the first place, mechanical department officials are notoriously underpaid. First-class mechanics and engineers get more per month than roundhouse and general foreman, and even master mechanics. Then, too, when one has climbed the ladder he is apt to be relieved from duty at a moment's notice because of the pull of some man who wants his position, and it is certainly ridiculous for the higher officials to expect men to accept twenty years of hard knocks at low wages, only to be asked to resign when they have secured something which in a measure rewards the efforts they have put forth.

I have noticed with pleasure the vigorous protests you have made in the *American Engineer* from time to time regarding the low salaries of motive power officials.

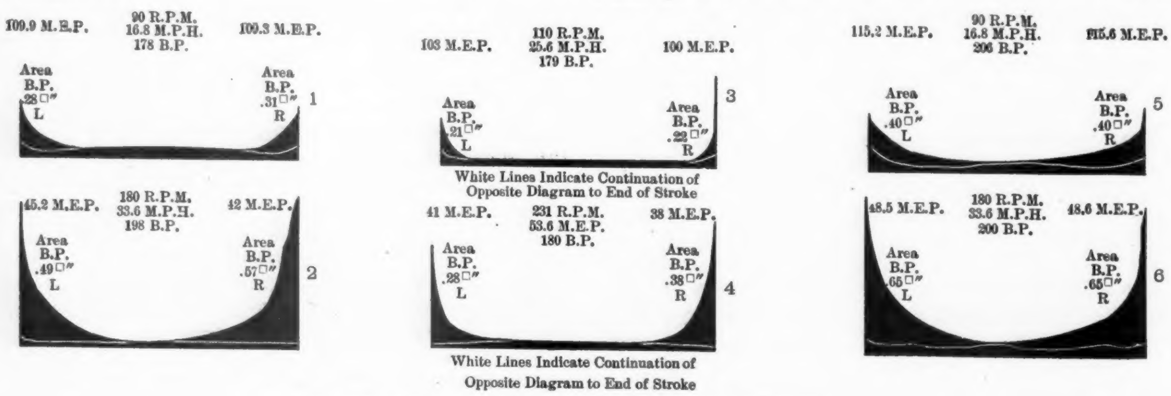
I had not the slightest trouble in securing a position at a salary which is better by 25 per cent than the best railroad position I have held, and that is only a start. Everything considered, I cannot see how railroads can expect to keep good men in their employ when they will be more appreciated elsewhere, both financially and in regard to stability of position. I see that the last sentence sounds egotistical, but there is no personal reference meant.

The fact is, that the young technical graduate today does not receive much encouragement from the railroads and the mechanical officials themselves are no better off. It will be different some day, but I cannot wait. I am one of many who regret to leave this field of work, but what else can we do? * * *

ALLFREE-HUBBELL VALVE GEAR.

To the Editor:

I have noted with a great deal of interest the comments on page 200 of your May number, and in connection with your reference to decreased compression, I want to call your attention to the fact that I think the correct expression of this thought is "the decreased volume of compression," in that we do not decrease the terminal pressure of compression.



COMPARISON OF BACK PRESSURE AND COMPRESSION.

There is a very neat distinction in decreasing volume in compression and decreasing compression, in that decreased compression necessarily means a decreased terminal pressure in compression, whereas a decreased volume in compression necessarily relates to a decrease in the negative work inseparable from compression, and I know of nothing that illustrates the point more distinctly or clearly than the six diagrams which I send you on the enclosed blue print.

Diagrams 1 and 2 represent the back pressure and compression from a 20 x 26 locomotive with piston valve having the usual link motion. Diagrams 5 and 6 represent the back pressure and compression on the same locomotive after it was equipped with a valve for the purpose of allowing compression and back pressure to blow past the main valve through the nozzles and stack to the atmosphere; the scheme being to add exhaust lap to the main valve, so as to delay exhaust opening, and which would necessarily advance exhaust closure, but the intention is, through this auxiliary valve, to let the increased volume in compression blow past the main valve to the atmosphere, and you will note that, as a result, the negative work in diagrams 5 and 6 is considerably greater than the negative work in diagrams 1 and 2, as a direct result of this early closure of the exhaust port.

You will note that diagrams 1 and 5 are taken at 90 r. p. m. Diagrams 2 and 6 are taken at 180 r. p. m., and you will see at a glance that the negative work of compression in diagrams 5 and 6 is much heavier than in diagrams 1 and 2, proving conclusively that the scheme of undertaking to blow compression past the main valve is not a success.

Comparing diagrams 3 and 4, which represent the back pressure and compression from Allfree-Hubbell locomotive No. 3 at 110 r. p. m., as against 90 revolutions, and diagram 4, taken at 231 r. p. m., as against 180 revolutions in 2 and 6, you will note that by our ability to delay the exhaust closure we decrease the negative work of compression through the decreased volume in compression, and by our ability to do this we are therefore able to reduce cylinder clearance and still maintain relatively the same terminal pressure of compression, as in diagrams 1, 2, 5 and 6. It seems to me that a blind man ought to be able to see the great advantages that must necessarily follow to do what we do do in every-day practice and as shown by the diagrams sent you herewith. Cards 1, 2, 5 and 6 are from a very well-known Western railroad.

IRA C. HUBBELL.

INFORMATION ABOUT MOTOR-DRIVING.

To the Editor:

In the May (1904) issue of your journal you were kind enough to publish my letter containing some notes upon the use of our old machine tools. In writing this letter I wish to call attention to two things: First, there are a great many men holding responsible positions to-day who are awake and keenly upon the alert, looking for information whereby they may be better fitted to fill whatever position they hold; second, many of those who give information by writing or otherwise assume that those for whom the instruction is intended are as well, or nearly as well, informed as themselves. Of such information given, much that would otherwise be valuable data is useless to many of us, owing to incompleteness.

In your issue for May an article entitled "The Power Required for Planer Driving" was published, which is very interesting; but, while appreciating in this case the data given, we, like Oliver Twist, "ask for more." The writer neglects to say whether the power required is the net power required to do the cutting or the gross power used for the motor and machine, including the cut. An analysis of the article mentioned shows, first, that three cuts were taken the total area of which was .086 sq. in. This area, at 20 ft. per min. cutting speed, equals a cutting rate of 20.64 cu. ins. of metal removed per minute. This amounts to a rate of 312.6 lbs. of metal removed per hour. The reason for giving these figures will be apparent later.

Referring to the table of figures given, it will be seen that, for a cutting speed of 20 ft. per min., 23.5 amperes were required, and for 26 ft. per min. 28.75 amperes were needed. From these figures it will be seen that, while the cutting speed increased about 30 per cent., the amperes increased only about 22 per cent. It would seem that the net power required for cutting would increase in the same ratio as the cutting speed. This being the case, it would further seem that the amount of amperes given represented gross power required. If this is true, then the natural inference is that the power needed to drive the machine increased at a less ratio than that of the speed of the machine.

To illuminate the matter, reference can be had to our notebooks, and here we have the following rules: First, for each cubic inch of metal removed per minute allow for a net power of ½ h. p.; second, the net horse-power required = W × .032 where W = the weight of metal removed per hour; third, the net horse-power required = W.0165 where, as before, W = the weight of metal removed per hour. Between the authorities for the second and third rules there is an ocean's width, both figuratively and literally. Note that these rules are for ordinary cast iron—a somewhat elastic set of

formulæ. According to the first and second rules, about 10 h.p. would be required for the net work of cutting, while by the third rule only about 5.34 h.p. will be needed. Hence the application of rules 1 and 2 would indicate that the amperes given in that article were for cutting only, while rule 3 would seem to show power used.

If this little "digging" for light should prove of as much interest to some of your readers as it has been to me, I will not regret it. Some of us are compelled to learn from the experience of others; hence the "digging." Let us apply rule 3 and assume that only 5.3 h.p. are needed for the net work of the cut; this, taking 23.5 amperes, or 7.24 h.p. (at 230 volts), as the gross power required, leaves 1.91 h.p. for running the motor and machine. We have noted that the increase of cutting speed was 30 per cent. and the ampere increase was 22 per cent. Applying these, we have 5.3 h.p. + 30 per cent. = total of 6.93 h.p., and 1.91 + 22 per cent. = 2.3 h.p., or a total of 9.2 h.p., which brings it somewhere near the horse-power of 28.75 amperes, which = 8.86 h.p.

The conclusions that can be drawn from these figures are: First, if the data given represent gross power, then rule 3 comes quite close in this particular case, and the performance is good. Such a result, to my mind, would indicate very soft metal and very sharp and well-shaped tools; also that 1.91 h.p. for driving this size machine, including the motor, seems very light indeed. But if the data given represent net horse-power, some rule between 2 and 3 might be deduced which would be of use in similar cases and under the same conditions.

To have made such data more beneficial there should have been given, in connection with the cutting speeds, the power required for running the motor and belts alone, the power required for moving the platen in each direction, and the net power for taking the cut, as well as the total gross power required at the various speeds.

Have I made myself clear in this request, that your contributors should give more attention to these little matters, and by so doing make their communications of more benefit to those who need them?

M. E.

EXPERIMENT WITH "PONY" AND FOUR-WHEEL TRUCKS.

To the Editor:

The increasing use of the 4-6-2 type of locomotive keeps before us the question of the relative safety of pony and four-wheel leading trucks. Considerations of cost and efficiency of the engine, necessary length of boiler tubes, sizes of turn-tables, and lengths of engine-house stalls, add to the interest. A rational view of the problem seems to be about as follows:

Having given a pair of wheels of given weight and tire section, running on a given rail, at a given speed, and carrying a given load with its center of gravity at a given height above the rail, its sensitiveness to derailment depends upon (1) the horizontal forces acting on it, due to the centrifugal tendency of the truck itself, and to the horizontal components of the forces transmitted by the cradle suspension links; and (2) the direction of the axle with relation to a radius of the curve of the track. The effect of (1) is, in both trucks, to throw the outer wheel over its rail, and quantitatively the effect per wheel is not much different in the two kinds of truck. The direction of the forward axle of the four-wheel truck necessarily acts in conjunction with the horizontal forces, but the direction of the pony-truck axle can be made to oppose the tendency of the horizontal forces, producing a truck which it is very difficult to derail.

With the object of investigating the action of the trucks experimentally, a model of the running-gear of a locomotive was prepared, as shown by the sketch. The wheels are of cast iron, the axles of steel, the hangers of wire, and the rest of wood. It was so arranged that the front part could be altered to represent either a ten-wheel or a mogul-wheel arrangement. In all the experiments the same pair of wheels was the leading pair, and each wheel was always on the same side of the engine. The equalizing arrangement was used so as to be sure each wheel had its proper load. The model was loaded with shot to bring its weight as follows:

	Ten-Wheel.	Mogul.
Weight on drivers	6 lbs. 10 oz.	7 lbs. 11 oz.
Weight on truck	2 lbs. 10 oz.	1 lb. 5 oz.
Total weight	9 lbs. 4 oz.	9 lbs

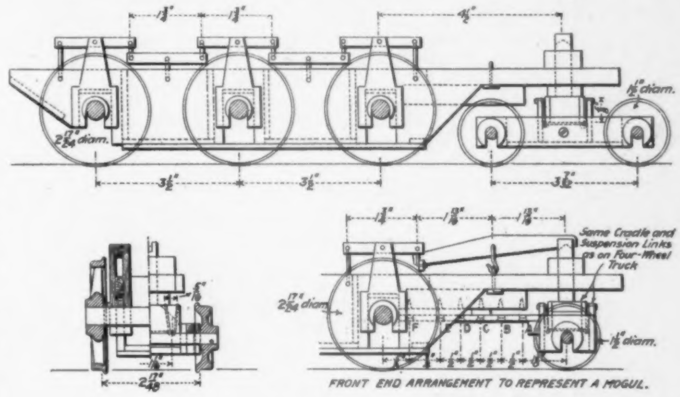
In order to investigate the effects of different lengths of radius bars, the model was so arranged that the radius bar pin, which was a wood screw, could be placed at A, B, C, D, E, or F. An inclined plane, 16 ft. long, and having its higher end 38 ins. above the lower one, was erected, on which to run the model. At the bottom of the incline there was a level curve of 14 ft. radius.

It is evident that, this being a reproduction of the running-gear of a locomotive to a scale of ½ in. to the foot, and all weights concerned being proportional to the size, the forces obtained will have the same directions as, and be proportionate to, those produced by the full-size locomotive on its track; therefore, this is a legitimate method of studying the subject.

The method adopted consisted in placing blocks inside both rails on the curve so that the flange would run onto the blocks. As they were of the same height as the rail, there was nothing to guide the wheels while on the blocks. The experiments consisted in determining the lengths of blocking that the trucks could pass over, afterward falling into their proper places on the rails. Preliminary experiments showed that the speed had little, if any, influence on these results, but the speeds were, notwithstanding, kept uniform by starting the model from the same point on the inclined plane for each trial. The inner rail was blocked as well as the outer one so as to have both wheels running on their flanges, with the same effective diameter. The results are given below:

Experiment Number.	Truck Used.	Location of Radius Bar Fulcrum.	Length of Blocking Required for Derailment (Inches).
1	Four-wheel		½
2	Pony	F	1¼
3	Pony	D	1½
4	Pony	C	6
5	Pony	B	12
6	Pony	A	12

The figures show that, although blocks but ½ in. long threw the four-wheel truck off, the pony truck with a short radius bar would follow the track for over 11 ins. with nothing to guide it, dropping into its place after passing the blocks. It is needless to say that the model would not back over anything like this obstruction. After derailment the cradle suspension links of the pony truck kept the truck frame in a fairly good position and the model rolled along smoothly. But the four-wheel truck turned more quickly, and the



EXPERIMENTAL TRUCKS.

wheels began to slide sidewise in a way that would have been disastrous if they had struck an obstacle. (The rails were attached directly to a board.) The experiments show also the advantages of short radius bars.

The rocking usually observed on a locomotive having a pony truck could not be reproduced here, but this rocking is not a necessary feature of the truck. It can be overcome by slight changes in the equalizing arrangement.

It appears, then, that the 2-6-0 and 2-6-2 types need not be rejected on the score of safety.

G. F. STARBUCK.

Waltham, Mass.

SCHOOL FOR TELEGRAPH OPERATORS WANTED.—"While the railroads are spending millions for various equipment to reduce expenses and improve operation, not one cent, nor one moment's time, is devoted to procuring and carefully training the operators they place in charge of their most valuable property. When an operator is to be employed it is a fish-net proposition and whatever is caught is pressed into the service, his habits and qualifications not fully known for some time afterward. One appropriate remedy for this condition would be the establishment of a telegraph school by as many as five or six large railroads, the only obligation required of each road being to furnish transportation for the student to school and employ such students as become operators, the school to be made thorough, teaching every branch of the work."—*J. C. Browne, before the St. Louis Railway Club.*

LOCOMOTIVE STEAMING CAPACITY.

BY L. L. BENTLEY, MECHANICAL ENGINEER, LEHIGH VALLEY RAILROAD.

An expression for the steaming capacity of a locomotive, to be satisfactory, must be simple in form and applicable to all cases and conditions. It is possible to get, by a combination and development of several of the methods already advanced, an expression for the required heating surface of a locomotive at maximum power which contains only two variables for simple engines and three for compounds. If, then, we have the required heating surface to supply steam to the cylinders at maximum power, and divide this into the actual heating surface of the locomotive, the quotient is a direct measure of the steaming capacity.

Mr. F. J. Cole, in his article in the AMERICAN ENGINEER for June, 1900 (page 176), has shown that the maximum power of a locomotive is a function of the piston speed, and that maximum power is developed at a piston speed of about 1,400 ft. per minute. Then the total heating surface is equal to the product of the maximum horse-power multiplied by a constant. (See AMERICAN ENGINEER, July, 1902, page 238.) These two facts are utilized as follows:

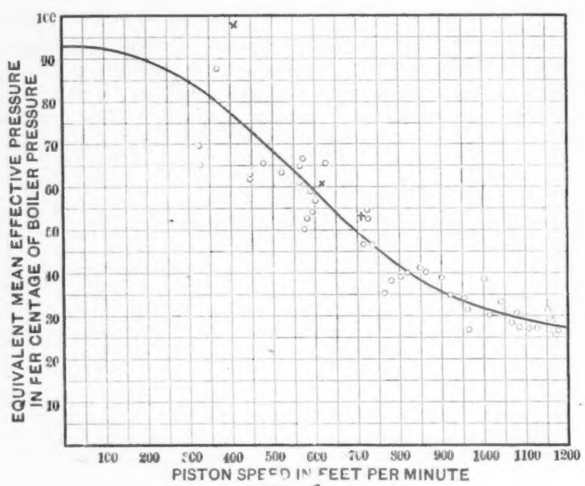


FIG. 1.

Let H = Horse-power.
p = Mean effective pressure.
L = Stroke in inches.
d = Diameter of cylinder in inches.
r = Revolutions per minute.
V = Speed in miles per hour.
P = Piston speed in feet per minute.
B = Boiler pressure in pounds per square inch.
D = Diameter of driving wheels in inches.
S = Heating surface of boiler in square feet.

Then for a simple locomotive of two cylinders,

$$H = \frac{p \times \frac{L}{12} \times \frac{3.1416d^2}{4} \times 4r}{33000} \qquad (1)$$

$$r = \frac{V \times 5280 \times 12}{60 \times 3.1416\,D} = \frac{1056V}{3.1416\,D} \qquad (2)$$

$$H = \frac{p \times \frac{L}{12} \times \frac{3.1416d^2}{4} \times \frac{4 \times 1056\,V}{3.1416\,D}}{33000} = \frac{p\,d^2\,L\,V}{375\,D} \qquad (3)$$

$$P = \frac{2\,L\,r}{12} = \frac{2\,L \times 1056\,V}{12 \times 3.1416\,D} = \frac{56\,L\,V}{D} \qquad (4)$$

For maximum power, P = 1400; therefore, we have $1400 = \frac{56LV}{D}$

$$\text{Whence, } V = 25\frac{D}{L} \qquad (5)$$

$$H\text{ (maximum)} = \frac{p\,d^2\,L}{375\,D} \times 25\frac{D}{L} = \frac{p\,d^2}{15} \qquad (6)$$

At a piston speed of 1,400 ft. per minute, p = .28 B (see F. J. Cole, in AMERICAN ENGINEER, June, 1900, page 176);

$$\text{Then } H\text{ (maximum)} = \frac{.28\,Bd^2}{15} = .01866\,Bd^2 \qquad (7)$$

If we make the assumptions that the cylinders of a simple locomotive require 28 lbs. of steam per horse-power per hour at the cut-off corresponding to maximum power, and that the boiler can evaporate as a maximum 15 lbs. of water from each square foot of heating surface in the same time, then for just sufficient boiler power we have:

$$28\,H\text{ (maximum)} = 15\,S \qquad (8)$$

$$28 \times .01866\,Bd^2 = 15\,S;$$

$$\text{Whence, } S = .0348\,Bd^2 \qquad (9)$$

Fig. 1 shows the results of a study of the data which were at hand concerning compound engines. The points on the diagram were plotted from indicator cards as follows: The mean effective pressure in the high-pressure cylinder was reduced to the equivalent pressure in the low-pressure cylinder by dividing by the ratio of the cylinder volumes. This equivalent pressure was averaged with the actual mean effective pressure in the low-pressure cylinder. Then for equality of work in both cylinders it is evident that the initial pressure (and therefore the mean effective pressure) in the low-pressure cylinder will vary inversely as the ratio plus 1 of the low-pressure cylinder volume to the high-pressure cylinder volume. The average pressure just mentioned was multiplied by this factor and divided by the boiler pressure, to give a proper basis of comparison.

This process is expressed symbolically as follows: Letting ph = M. E. P. in the high-pressure cylinders, pl = M. E. P. in the low-pressure cylinders, and q = ratio of cylinder volumes;

$\frac{ph}{q}$ = equivalent M. E. P. for the high-pressure cylinder in low-pressure cylinder.

$\frac{\frac{ph}{q} + pl}{2} \times (q + 1)$ = equivalent mean effective pressure for the high-pressure cylinder exhausting to atmosphere.

This value in percentage of the boiler pressure was plotted on the diagram, each point representing an indicator card. The curve drawn through the average of these points is very similar to that given by Mr. F. J. Cole for simple engines. If the horse-power be computed for various speeds with pressures as given by this curve it will be found that the maximum horse-power is attained at a piston speed of about 750 ft. per minute.

For two cylinder compounds, assuming the work done to be equally divided between the cylinders, we can now write the following by analogy with equation (3):

$$H = \frac{p\,l\,(d\,l)^2\,L\,V}{375\,D} \qquad (10)$$

For compounds at maximum power, $P = \frac{56\,L\,V}{D} = 750;$

$$\text{Whence, } V = 13.39\frac{D}{L} \tag{11}$$

$$\text{Hence } H\ (\text{maximum}) = \frac{p\,l\,(d\,l)^2 L}{375\ D} \times 13.39\frac{D}{L} = \frac{p\,l\,(d\,l)^2}{28} \tag{12}$$

At 750 ft. per minute piston speed, $p\,l = \frac{.46\ B}{q+1}$ (see diagram); so that $H\ (\text{maximum}) = \frac{46\ B\ (d\,l)^2}{28\ (q+1)}$ (13)

If we assume that at the cut-off corresponding to maximum power the cylinders of a compound locomotive require 25 lbs. of steam per horse-power hour, and that, as before, the boiler is capable of evaporating 15 lbs. of water per square foot of heating surface, then for just sufficient boiler power, we have:

$$25\ H\ (\text{maximum}) = 15\ S \tag{14}$$

Substituting,

$$25\left[\frac{.46\ B\ (d\,l)^2}{28\ (q+1)}\right] = 15\ S, \text{ and } S = .0274\frac{B\ (d\,l)^2}{q+1} \tag{15}$$

And, similarly, for four-cylinder compounds,

$$S = \frac{.0548\ B\ (dl)^2}{q+1} \tag{16}$$

Of course, the assumptions made above are not true for all locomotives, but they represent average good conditions.

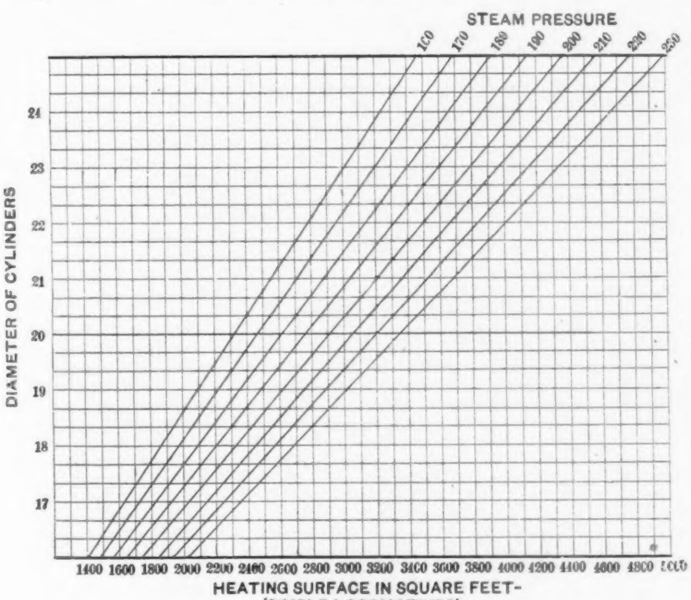


FIG. 2.

from this position the heating surface is read on the scale at the bottom.

Fig. 3, which shows the heating surface required for a four-cylinder compound locomotive to furnish sufficient steam at maximum power, has been constructed from equation (16). The value of $\frac{(d\,l)^2}{q+1}$ is taken from Table I. Fig. 3 can also be used for two-cylinder compounds by taking half the result.

TABLE II.

PASSENGER ENGINES.—FROM SUPPLEMENT TO "AMERICAN ENGINEER," JUNE, 1903.

Road.	Type.	Cylinders.	Actual S.	Calc. S	Steaming Capacity at Max. Power.
Plant System ..	119	4-c. bal. com.	2793	1812	1.54
C. & N. W.....	D	Simple	3015	2784	1.08
C., R. I. & P....	1301	Simple	2806	3000	.94
C. R. R. of N. J.	....	4-cyl. com.	2657	1597	1.66
L. S. & M. S....	I-1	Simple	2917	2930	.995
B., R. & P......	162	Simple	3007	3140	.96
Mo. Pac.	1118	Simple	2953	2784	1.06
L. S. & M. S....	J	Simple	3362	2920	1.15
N. Y. C. & H. R.	I-2980	Simple	3505	3070	1.14
Pa. Lines	E 2 A	Simple	2639	3000	.88
P. R. R........	E-2	Simple	2640	3000	.88
I. C.	1001	Simple	3191	2784	1.14
C., M. & St. P...	A-2	4-cyl. com.	3215	1812	1.77
Col. Mid.	201	4-cyl. com.	2625	2315	1.17
C., B. & Q......	1586	4-cyl. com.	2990	1903	1.57
A., T. & S. F....	....	4-cyl. com.	3029	1994	1.52
C. R. R. of N. J.	....	Simple	1834	2250	.815
C. & O.........	147	Simple	3533	3360	1.05
C. R. R. of N. J.	590	Simple	2967	3065	.97
L. V.	10-D-17-W	4-cyl. com.	2708	2315	1.17
Nor. Pac.	284	Simple	3463	3360	1.03
I. C.	1000	Simple	3534	2784	1.23
A., T. & S. F....	P-14 A	4-cyl. com.	3738	2315	1.62
N. Y. C........	1410	Simple	2437	2784	.875
C. & A.........	601	Simple	4078	3690	1.11

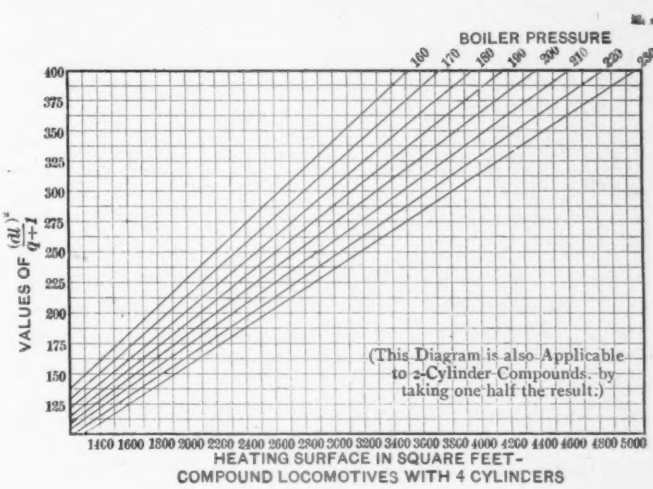


FIG. 3.

TABLE I.

VALUES OF THE EXPRESSION $\frac{(d\,l)^2}{q+1}$ FOR VARIOUS SIZES OF CYLINDERS.

Diameter of High-Pressure Cylinder.

Diameter of Low-Pressure Cylinder.	13	13½	14	14½	15	15½	16	16½	17	17½	18	18½	19	19½	20	20½	21	21½	22	22½	23	23½	24
22	125	132																					
23	128	135	143	150																			
24	131	138	146	154	162	169																	
25		142	149	157	165	173	182																
26			152	160	169	177	186	194	202														
27				163	172	181	190	198	207	216													
28					175	184	193	202	211	220	229	238											
29						187	196	206	215	224	234	244	253	262									
30							198	209	219	229	238	248	258	267	277	287							
31								212	222	232	243	252	263	273	283	293	303	312					
32									225	236	246	257	268	279	289	299	309	319	329				
33										240	250	261	272	282	293	303	314	324	335	346	356		
34											253	264	275	286	297	308	320	332	342	352	362	374	
35												267	279	291	302	313	324	336	347	358	369	380	392

Fig. 2 has been constructed from equation (9) and shows the heating surface required for a simple locomotive to furnish sufficient steam at maximum power. To use this diagram find the cylinder diameter at the left and proceed toward the right to the inclined line corresponding to the steam pressure;

Tables II. and III. show these methods applied to the comparison of locomotives, tabulated in the supplement of the AMERICAN ENGINEER for June, 1903. The compounds nearly all show a large excess of boiler power, and were more data available, the curve shown in Fig. 1, or some of the assumptions

made, might be changed somewhat, but the general accuracy is confirmed by the fact that if the heating surface is figured for the equivalent simple engine, the excess boiler capacity is still shown.

The general experience with compounds has been that they are more sucessful at low speeds, such as are attained in freight service, than in high-speed passenger service, and it would appear that designers have supplied the compounds with heating surfaces unnecessarily large with the idea of helping them out at high speeds. An examination of the curve shown in Fig. 1 shows this to be useless, as at a piston speed of about 750 ft. per minute the equivalent pressure decreases faster than the piston speed increases, and hence at that point the cylinders use steam at their maximum rate. That this point of maximum power for compounds occurs at piston speed so much lower than for simple locomotives is probably due to the fact that for the compounds the steam must be handled through ports and valves twice as often as in the case of simple engines.

TABLE III.

FREIGHT LOCOMOTIVES.—FROM SUPPLEMENT TO "AMERICAN ENGINEER," JUNE, 1903.

Road.	Type.	Cylinders.	Actual S.	Calc. S	Steaming Capacity at Max. Power.
L. S. & M. S....	B-1	Simple	2874	3070	.94
Sou. Pac.	2026	2-cyl. com.	3025	2025	1.49
N. Y. C.........	G. 2.	2-cyl. com.	3480	2125	1.64
P. R. R.........	H. 6-A	Simple	2842	3440	.83
Nor. Pac.	Y-2	4-cyl. com.	3414	2020	1.69
N. Y. C.........	2399	4-cyl. com.	3480	2020	1.72
C., R. I. & P....	1603	Simple	3264	3350	.98
A., T. & S. F...	836	4-cyl. com.	2965	2642	1.12
I. C.	639	Simple	3203	3870	.83
D., L. & W.....	808	Simple	3168	3070	1.03
Burlington	580	Simple	3827	3520	1.09
Erie	1565	4-cyl. com.	3011	2178	1.38
Nor. Pac.	Y-3	4-cyl. com.	3646	2018	1.80
Soo	600	4-cyl. com.	3000	2482	1.21
Great Northern..	100	Simple	2965	3220	.92
A., T. & S. F....	824	4-cyl. com.	4266	2425	1.75
I. C.	640	Simple	3500	3870	.90
L. V.	....	4-cyl. com.	4105	2610	1.58
N. Y. C........	G-4	4-cyl. com.	4142	2282	1.81
Union	95	Simple	3321	3690	.90
A., T. & S. F....	989	4-cyl. com.	4681	2824	1.65
A., T. & S. F....	900	4-cyl. com.	5366	2940	1.82
A., T. & S. F....	940	4-cyl. com.	5390	3320	1.62

REDUCED COST OF OPERATION THROUGH GRADE AND CURVATURE REDUCTION.

An admirable paper on this subject read before the American Railway Engineering and Maintenance of Way Association by Mr. J. B. Berry, chief engineer of the Union Pacific Railway, contains the following conclusions:

Gradients.—A reduction of gradient on an engine district 100 miles long so as to require one less daily train in each direction will result in a saving of $37,230 per year. For other lengths of district or a greater reduction in the required number of trains, the saving in operating expenses per year will be in direct proportion to this. Any reduction in length of helper grades or other change that will eliminate one helper engine of the same size as the standard road engine will result in a saving of $14,673 per year, providing that the helper engines average 100 miles per day. For other average daily mileage of helper engine the saving is in direct proportion to this.

Distance.—A saving in distance will result in the following savings per year per daily train one way:

Class A.—Distances so short as not to affect wages of engine or trainmen, 2.6 cents per foot, or $137 per mile.

Class B.—Distances affecting train wages, but not affecting the number of side tracks required, 3.7 cents per foot, or $196 per mile.

Class C.—Distances so great as to affect the number of side tracks required, 4.8 cents per foot, or $252 per mile.

Curvature.—The elimination of degrees of total curvature will result in a saving per year per daily train one way of 23 cents per degree for uncompensated curvature and 19 1-3 cents per degree for compensated curvature.

Rise and Fall.—The elimination of one foot of rise and fall will result in a saving per year per daily train one way as follows: Class B, where grades are such as to require shutting off steam in descending but not to require application of brakes on minor grades, 55 cents per foot and on ruling grades, 96 cents per foot. Class C, where grades are such as to require the application of brakes on minor grades, $1.15 per foot and on ruling grades $1.57 per foot.

The proportions of the boilers being installed at the Fifty-ninth Street power plant of the underground rapid transit railway in New York City are interesting for their great size. Each of the 60 boilers is of 600 h.p. rated capacity and delivers superheated steam at 200 lbs. pressure. The boilers are of the water-tube type, built by The Babcock & Wilcox Company, each having 294-4-in. tubes, 18 ft. long; the tubes are arranged in 21 vertical sections, each 14 tubes high. Each boiler is provided with 3 steam drums, 23 ft. 3 ins. long by 42 ins. diameter; these drums are of open hearth steel, 9-16 in. thick, of 56,000 lbs. tensile strength.

Main Line Electric Train on an English Railway.—The North Eastern Railway instituted electric service on its main line, between the Central Station and Benton, about a month ago. The current is brought from the Newcastle-on-Tyne Electric Supply Company, the transmission voltage being 6,000, which is reduced to 600 volts for the third rail at sub-stations. Thirty-seven miles of road are operated electrically, with two and four tracks, the schedules being reduced from 35 minutes by steam to 23 minutes by electricity for local trains, and to 15 minutes for express trains.

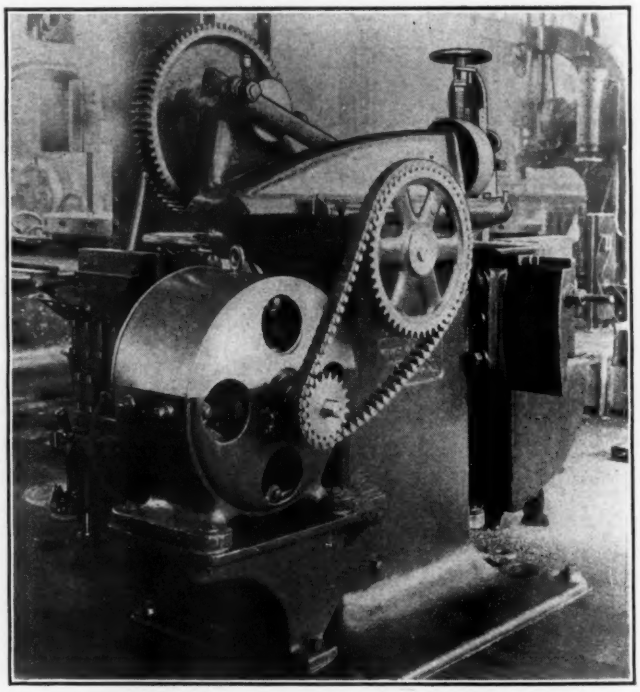


FIG. 57.—A COMPACT ARRANGEMENT OF VARIABLE-SPEED MOTOR DRIVING UPON A 12-IN. HEWES & PHILLIPS CRANK SHAPER.—5 H.P. CROCKER-WHEELER MOTOR.

Remarkable Acceleration by Automobiles.—The recent automobile speed trials at Nice developed facts which should set people thinking as to the possibilities of internal combustion motors for transportation purposes. One, a 100 horsepower automobile, made a remarkable record of a mile from a standing start in 53 3-5 sec., or at the rate of 68 miles per hour. This machine is entitled to the utmost respect. In these trials one of the machines made a record of 82.24 miles an hour, and another one 94.74 miles an hour. These speeds have a significance much greater than that connected with the construction of mere racing machines, and they point to the possibility of a much more important and practical use of internal combustion motors than that of driving pleasure or racing automobiles.

THE APPLICATION OF INDIVIDUAL MOTOR-DRIVES TO OLD MACHINE TOOLS.

McKEES ROCKS SHOPS.—PITTSBURGH & LAKE ERIE RAILROAD.

BY R. V. WRIGHT, MECHANICAL ENGINEER.

XII.

SHAPERS.

In continuation of the description of the applications of motor-driving to reciprocating tools which was taken up in the preceding article of this series, here are described such applications to shapers. Figs. 57, 58 and 59 illustrate the application of individual variable-speed motor-driving to two old shapers at the McKees Rocks Shops. Both of these installations are quite simple, the object, of course, being to make the combination as compact as possible.

A Hewes & Phillips 12-in. crank-shaper is shown in Fig. 57. In order to apply the motor it was only necessary to replace the belt speed-cone by the large Morse silent-chain sprocket and to furnish the cast iron bracket to support the motor, the details of which bracket are shown in Fig. 58.

The motor used here is a Crocker-Wheeler 5-H.-P. compound-wound motor, operated by a type 40-M.F.-18 controller of the same make; this combination gives the total maximum speed of 65 strokes per minute. The panel board, which is shown to the left in Fig. 57, carries on its rear side the main switch, fuses and the circuit-breaker, and on its front side the controller.

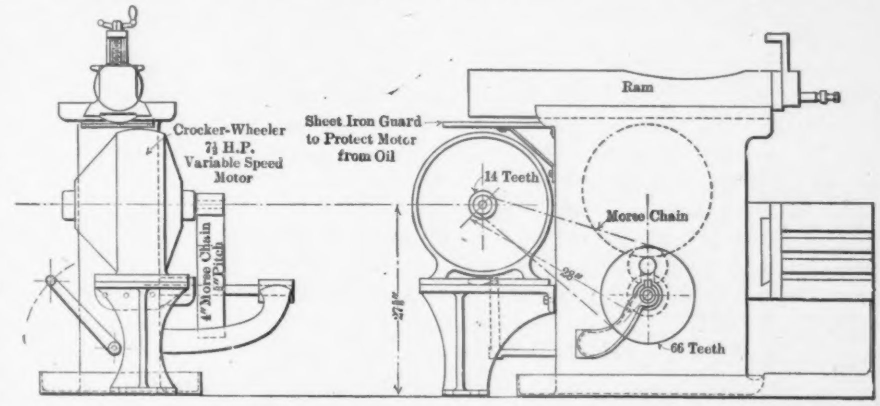


FIG. 59.—THE ARRANGEMENT OF MOTOR DRIVING USED UPON THE 24-IN. GOULD & EBERHARDT CRANK SHAPER.—7½ H.P. CROCKER-WHEELER MOTOR.

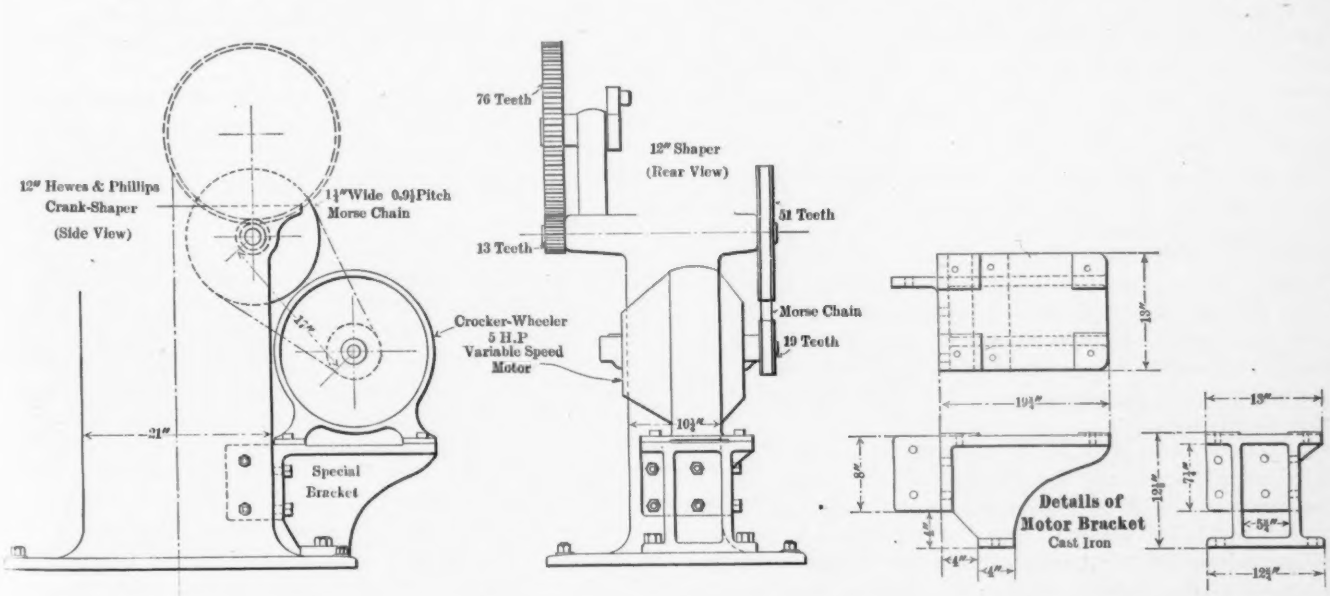


FIG. 58.—DETAILS OF THE MOTOR DRIVE APPLIED TO THE HEWES & PHILLIPS SHAPER, SHOWING STYLE OF MOTOR SUPPORT BRACKET.

An application to an old Gould & Eberhardt 24-in. crank-shaper is shown in Fig. 59. The method of applying the motor is practically the same as for the shaper described above. The belt cone was replaced by a silent chain sprocket and a bracket made to support the motor at the rear of the tool, as shown in the drawing.

This drive is of particular interest in this connection, as it illustrates the flexibility of the silent chain in this class of work. The size of the largest sprocket which could be used was so limited that it was impossible to use a chain with very large pitch. The pitch was made as large as possible, and then the chain was merely made wide enough so that it would have sufficient strength.

This shaper has a maximum speed of 71 strokes per minute and is driven by a Crocker-Wheeler 7¼-H.-P. compound-wound motor, in connection with a 40-M.F.-18 controller. This shaper has two runs of gearing, and these, in connection with the motor, furnish a wide range of speed. The panel board and the controller are placed in the same relative position as for the shaper described above.

REMARKABLE SERVICE OF PISTON VALVES.—A set of "American" semi-plug piston valves with their valve cages have just been removed from a locomotive on the Buffalo & Susquehanna Railroad in order to be sent to the exposition at St. Louis. These valves were applied June 11, 1901 and have been in continual service up to March 31, 1904, a little over two years and nine months. In this time no repairs of any nature have been made to the valves and they have not been removed from the valve cylinders except for the application of metal packing and once for examination. Mr. C. R. Williams, general master mechanic of the road, stated that during this service no blow whatever has been detected in the valves and they were perfectly tight when removed." He says: "From the present condition of the valves I see no reason why they should not continue to give this same service for five years yet." During the period of service mentioned, the engine has made 91,340 miles. A profile of part of the road on which this engine has been running shows that it has done a large amount of drifting. Mr. Williams states that the reverse levers of this engine are dropped while drifting, in the same manner as slide valve engines are handled, and that the engine drifts freely, although there are no by-passes or relief valves in the steam chests.

MALLET ARTICULATED COMPOUND LOCOMOTIVE.

0-6-6-0 TYPE.

BALTIMORE & OHIO RAILROAD.

(See AMERICAN ENGINEER for May, page 167, and June, pages 218 and 237.)

In such road trials as could be made before this locomotive was sent to the World's Fair at St. Louis the performance was entirely satisfactory. Those who witnessed the trials were impressed with the fact that in hauling a very heavy train on slippery rails, without sand, both engines did not slip simultaneously and the tension on the drawbar was never relieved as it is in the case of an ordinary engine. Further trials will be deferred until the locomotive is put into regular service.

This engine was designed to haul 2,222 tons, in 50-ton cars, up a grade of 1 per cent. on straight track, at a speed of 10 miles per hour, under fair conditions of weather and rail, the engine working compound and the resistance being figured at 31.5 lbs. per ton. It is to work between Cumberland, Md., and Sandpatch. The design was prepared for 30 deg. curves and 20 deg. reverse curves, without tangents between.

The engine being very large to be handled in the shops, advantage was taken at every possible opportunity to use bushings in the running gear, so that running repairs might be made without taking the engine over the road except when absolutely necessary.

The boiler has been already described. The locomotive stands so high as to render it necessary to use an unusually low dome, which is made of cast steel, with an annular cavity partially surrounding it, leading from the throttle valve connection to the high pressure dry pipes on the right and left sides of the dome. The throttle itself is outside of the dome and upon one side of it. This illustrates the difficulty in the matter of clearance for such a large boiler. The high pressure cylinders are upon the rear engine, the frames of which are secured to the boiler and fire box. The boiler is supported and attached to the rear engine frame by means of a ½-in. plate at the rear end of the fire box, extending the full width of the mud ring, and also by an intermediate sliding support midway between the rear and intermediate drivers and a sliding support at the front end of the fire box, all attached to the mud ring. The high pressure saddle does not separate in the center of the space between the frames, the parting being at one side in order to provide space for the joint of the receiver pipe, which extends forward from the center of the saddle. This saddle is secured to the belly of the boiler, which is reinforced by 1-in. plates inside and outside of the shell-plates at this point.

The boiler is supported upon the front engine by a sliding support with lateral and longitudinal motion to provide for expansion and contraction of the shell and for side movements in curving, this being located between the rear and the intermediate drivers of the front engine. The boiler is further supported on the forward engine by a sliding support with lateral and longitudinal motion, which is located between the front and intermediate drivers, and is adjusted to take the load of the boiler only at such times as inequalities of the road bed make it necessary. This support is provided with a spring-centering device having an initial pressure of about 13,000 lbs. All the wearing surfaces of the boiler supports are fitted with wrought, case-hardened bearings working on the same material, or brass.

The articulated joint between the front and rear engines is of cast steel, and very substantial. The front engine frames also have hinge supports of cast steel, so constructed as to break in case of excessive strain on the articulated joint, which will save the more expensive castings. The frames of both front and rear engines are 4½ ins. wide, and have a minimum depth of 5 ins. for the top rails. The driving wheels are 50 ins. in diameter, with all tires flanged; the driving journals are 9 x 13 ins., and the total lateral motion of the driving wheels is 1-16 in. between hub faces and boxes, or a total of ⅛ in. for each pair of wheels.

Steam is brought from the dome through 5-in. dry pipes to the high-pressure steam chests, where it passes through 10-in. piston valves to the high-pressure cylinders, and exhausts through a 9-in. receiver-pipe with a ball-joint at the back end and a sliding-joint and also a ball-joint at the front end, reaching the double-ported slide valves for the low-pressure cylinders of the leading engine. This exhaust pipe provides for 30 deg. curves. There is but one intercepting valve, and that is of the Mellin type, which has been so successfully used in the Richmond two-cylinder compounds. The high-pressure pistons are of cast iron and hollow, with snap rings, while those of the low-pressure cylinders are of cast steel with cast iron bull rings. The cross-heads are of the alligator type. The valve motion is arranged to cut off equally at 17 ins. of the stroke. The high-pressure valves have ⅛-in. outside lap. The low-pressure valves have 1-in. outside lap and ¼-in. exhaust clearance. The valve gear is of the Walshaert type, which was absolutely necessary because no room was available inside the frames. The reversing is done by air, with a very ingenious construction of reverse lever. The flexible wheel base rendered necessary a flexible connection of the valve motion to the low-pressure cylinders, which was accomplished by long lifting rods, with a compound hinge joint at the top, at the side of the boiler, and a ball joint at the bottom. The hinge joint at the top avoids the twisting of the rod, and the rod is made long enough so that the side motion of the forward engine does not introduce a serious error in the position of the link block.

The boiler has two sliding fire doors. The grates have 40 per cent. air opening, and are arranged to rock in six sections. The ash pan has 10 sq. ft. of air opening, 80 per cent. of which is under the control of dampers.

The cab is of 3-16 in. steel plate. Westinghouse brakes are fitted to the engine and tender. Two 4-in. Coale enclosed pop-valves are set at 240 lbs., and one 4-in. Coale muffled valve is set at 235 lbs. pressure, located in the roof sheet in front of the cab.

The tender frame has 10-in. steel channel center sills and 8-in. channel side sills. It carries 7,000 gallons of water and 13 tons of coal.

Additional detail engravings will be presented in another issue.

ENORMOUS PASSENGER-CARRYING CAPACITY OF NEW YORK STREET RAILWAYS.—Statistics collected by the State Railroad Commission of New York show that for the year ending February 29 the car lines in Manhattan alone carried 670,000,000 passengers, exclusive of transfers; this is more than one million more passengers than all the steam railroads of the United States carried in the same period, their record being 568,000,000 passengers. In Greater New York more than one billion passengers were transported. It is interesting to know of the enormous gain of 37,000,000 passengers on the elevated lines during the year, whereas the surface lines had only a trivial increase of 144,300. This would indicate that the surface lines are working very nearly up to their total capacity.

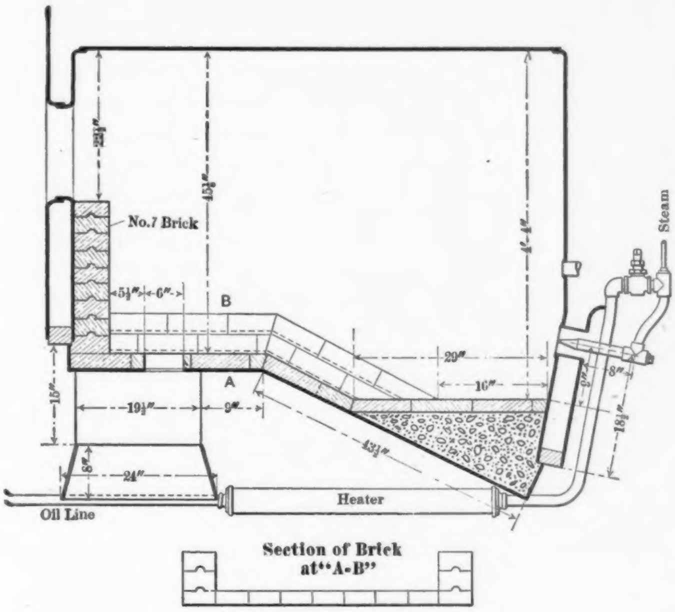
A remarkable long-distance run of a passenger train is recorded for "The Ocean Mail" special of the Great Western Railway of England, on May 9, 1904, 246¾ miles, from Mill Bay dock, Plymouth, to Paddington Station, London, made in 3 hours 46½ minutes, this being at the rate of 65.07 miles per hour. The train weighed 140 tons behind the tender.

Internal Friction of Locomotives.—In recent tests on the Berlin-Zossen Military Railroad a steam locomotive developed a maximum of 1,800 h.p. The resistance being about 25 lbs. per ton, the net power was approximately 1,200, leaving about 600 h.p., or over 30 per cent. of the power of the engine as the amount required to move itself against all resistance.

A NEW ARRANGEMENT OF FUEL OIL BURNERS FOR LOCOMOTIVES.

SOUTHERN PACIFIC RAILWAY.

Heretofore all arrangements for burning liquid fuel in locomotives have introduced the flame at the back end of the fire box, projecting the flame towards the front and generally under a fire brick arch extending backward from the front tube sheet. The Southern Pacific Railway has employed oil burning very extensively in locomotives, and from the experience of a

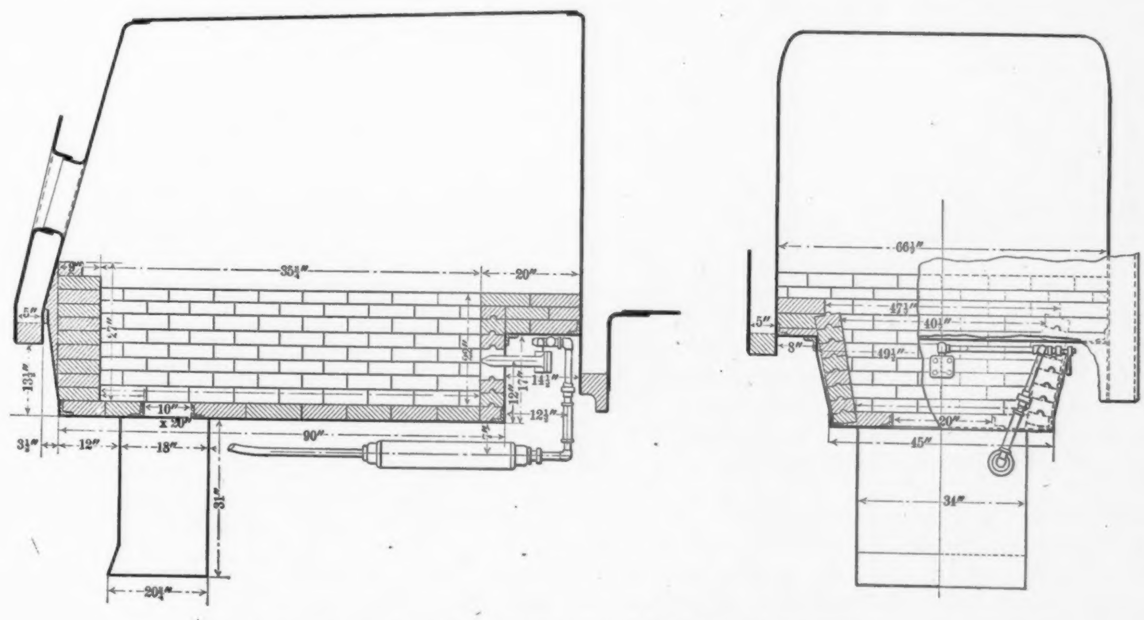


APPLICATION TO A NARROW FIREBOX.

fire brick arch is dispensed with altogether. At the back end of the fire box an opening through the plate floor, which takes the place of the ash pan, admits air vertically upward against the flame immediately in front of the fire brick wall. This plan projects the flame toward the rear of the fire box and in a direction opposite to that of the natural course of the draft. There is no obstruction in the fire box and the air coming direct upon the flame, from beneath, deflects it in an upward direction, where it turns to travel forward towards the tubes. This gives a long flame-way for the fuel and subjects a larger portion of the surface of the fire box to a direct heat and prevents the concentration of the heat in certain portions of the box, which necessarily takes place in connection with the usual method. In the saving of the cost of the fire-brick arches alone, the saving due to this method is enormous, and to this must be added a very material improvement in the matter of the injury to the fire box sheets, which has been a serious difficulty in large locomotives where the fire, with oil fuel, is greatly forced.

The second engraving illustrates the application to a new 2-8-0 type, wide fire box locomotive. In this case the burner is placed inside of the fire box, protected by brick-work.

This road now has 65 locomotives equipped in this manner and the application is being made to all engines as fast as possible. Methods of using oil in locomotive fire boxes have been studied with special care on this road and until the development of this arrangement, Mr. Heintzelman considers that all have been working on an entirely wrong principle. This was probably for the reason that no one could see how oil could be burned in a locomotive in any way except that of usual practice. There is good reason to believe that this system will continue to be as successful as at present and that it will revolutionize methods of burning fuel oil in this service. This seems to be the most important recent contribution to progress in fuel oil burning, and it seems likely to result in great advantage to the life of firebox sheets and tube ends.



APPLICATION TO A RECENT LOCOMOTIVE WITH WIDE FIREBOX.

A NEW ARRANGEMENT OF FUEL OIL BURNERS FOR LOCOMOTIVES—SOUTHERN PACIFIC RAILWAY.

number of years Mr. T. W. Heintzelman, superintendent of motive power, at Sacramento, California, and Mr. J. G. Camp, general foreman, have brought out a new method which seems likely to revolutionize this practice.

at the rear of the fire box and below the fire door. The usual

The accompanying engravings illustrating methods of applying the new arrangement, show that the burner is placed at the front end of the fire box; in one case the atomizer passes through a hollow stay-bolt, in the front water leg, projecting the fuel backward, against a vertical fire brick wall which is built

GASOLINE ENGINES FOR TURNING A DRAWBRIDGE.—The new drawbridge of the Central Railroad of New Jersey crossing Newark Bay is operated by two 75-h.p. gasoline engines supplied by Fairbanks, Morse & Co. They are of the three-cylinder vertical type, and by their use the engine-room equipment is greatly simplified. Either engine may be coupled to a common jack-shaft by means of friction couplings, so that in case of accident to one, the other engine will be immediately available. Circulating water is supplied by small pumps driven by the engines. Storage tanks for gas are provided on a special platform outside of the house and below the floor-level. For hoisting supplies and fuel a small crane is provided, which derives its power from one of the engines.

HIGH SPEED PLANING.

The G. A. Gray Company, of Cincinnati, Ohio, have prepared a leaflet on the subject of high-speed planing, directing attention to practice which they recommend, from which the following statements are taken:

The ordinary way to speed up a planer is to increase the speed of the countershaft. This is practicable only within certain limits, because it results in increasing the return speed in proportion to the cutting speed, and thus the former is usually increased beyond its practical limit long before the latter reaches the cutting limit, especially where modern tool steels are used.

Some variable-speed countershafts are in use, which permit a wide range of cutting speed, with a constant return speed; but where these are not available it is a good plan to put in a pulley of larger diameter on the countershaft for the cutting stroke instead of too greatly increasing the speed of the shaft itself.

It will be readily understood that in practice a certain amount of time is necessary in order to shift the belts and start the table in an opposite direction at each end of the stroke. The greater the speed the greater will be the momentum of the revolving parts and consequently the greater the delay necessary to overcome them. On a very short stroke the time so lost may offset the gain due to increased speed. In view of this, this company recommends for return speeds such limits as long experience has proved to be most practicable for general purposes, viz.: From 60 to 80 ft. per min., depending upon the size and length of the planer.

When an extreme cutting speed is wanted they substitute a special shifter lever and front dog for those ordinarily used; the object being to effect the contact of the dog and lever higher up, in proportion to the speed, and thus preserve the smooth reverse motion which characterizes the operation of Gray planers. This company is frequently asked the question: "What is the quick return ratio of your planers?"

The person asking such a question seems to assume that this ratio determines the efficiency of a planer, and that a comparison of such ratios for various planers indicates their relative efficiencies. Both of these assumptions are radically wrong. The mere ratio of return and cutting speeds is no indication whatever of the efficiency of a planer, and a comparison of such ratios for various planers is of no value unless the actual cutting speeds are known. The man who asks, "What is the quick-return of your planer?" assumes that a return of 4:1 must be more efficient than 3:1. If the cutting speeds are alike on both planers, then the comparison is valid; but if the cutting speeds are not alike, then both speeds must be known before a basis of comparison can be established. Thus, a planer with a quick-return of 2:1 may be really more efficient than another with a quick return of 4:1. It depends entirely on the actual cutting speeds, as may be understood from the following elementary calculation:

Assuming the cutting speed to be 24 ft. per min., then a stroke 12 ft. long is made in ½ min.; and if the quick return is 2:1, then the return stroke is made in ½ of ½ = ¼ min. Thus, one "round trip" is made in ½+¼ = ¾ min., *i. e.*, at the rate of 80 round trips per hour.

Assuming the cutting speed to be 18 ft. per min., then a stroke 12 ft. long is made in 12-18 = 2-3 min.; and if the quick return is 4:1, then the return stroke is made in ¼ of 2-3 = 1-6 min. Thus, one "round trip" is made in 2-3+1-6 = 5-6 min., *i. e.*, at the rate of 72 round trips per hour.

Similar calculations with various other cutting speeds and return ratios give the results embodied in the following table:

Cutting sp'd of 18 ft. and a return of	4 :1 gives	72 round trips per hr.
Cutting sp'd of 20 ft. and a return of	3 :1 gives	75 round trips per hr.
Cutting sp'd of 24 ft. and a return of	2 :1 gives	80 round trips per hr.
Cutting sp'd of 40 ft. and a return of	2 :1 gives	133 round trips per hr.
Cutting sp'd of 60 ft. and a return of	1¼ :1 gives	166 round trips per hr.

From the above it is plainly evident that the cutting speed is the principal factor in determining and increasing the efficiency of a planer, and of infinitely more importance than the mere magnitude of quick-return ratio. Recognizing this fact, the Gray planers are designed and constructed so that they may be run at the fastest speeds which the work and tool steels will stand.

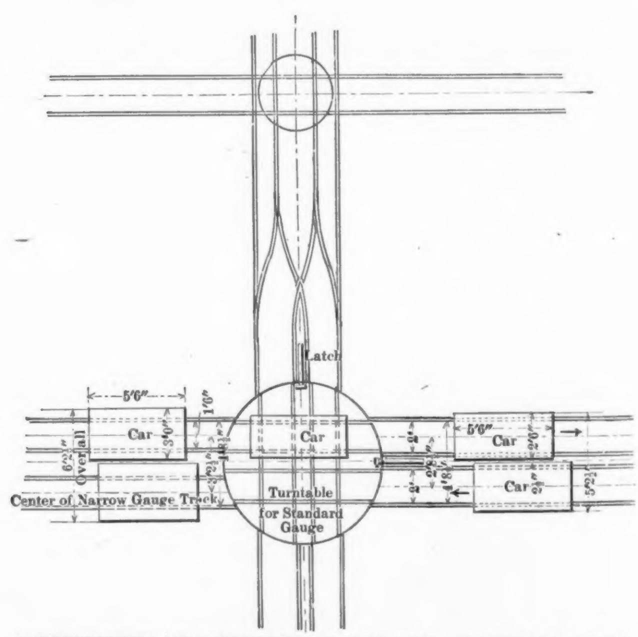
The G. A. Gray Company from their experience in planer construction have a great deal of additional information with respect to planer practice and those requiring further information should apply to them.

MATERIAL TRACKS IN SHOPS.

BY J. H. MORTON.

In these days employers cannot afford to have men standing around waiting for the transfer of material, and nowhere is it more important to provide efficient track systems than in the railroad machine shop. The arrangement of a single track, either narrow or standard gauge, for the handling of material does not entirely meet present day conditions, even when well provided with branches. Space does not admit of providing a double gauge track on account of the loss of valuable floor space, and no railroad can accommodate itself entirely to the inconvenient narrow gauge system through which standard gauge cars can never pass.

A narrow gauge track down the center of a standard gauge or one formed with a single extra rail to provide a narrow



A CONVENIENT ARRANGEMENT OF MATERIAL TRACKS IN SHOPS.

standard gauge track with three rails are familiar systems in many shops, but the necessity for turning one truck off on a side track, to pass another in an opposite direction, is a serious disadvantage of this arrangement. As far as the writer is aware, a double narrow gauge system between standard gauge tracks, as devised by him for large new shops now in construction, has not as yet been adopted elsewhere. The accompanying sketch clearly shows the advantages of such a system. By using each narrow gauge track, for one direction only, a continuous stream of trucks can be kept moving in opposite directions without causing blocking, which is so familiar on a single track. When necessary standard gauge trucks, or cars, may be brought into the shops on the outside rails—and in this case, of course, it need not occur often—the narrow gauge tracks must be cleared. An 18-in. gauge and trucks 3 ft. wide may pass each other on the tracks shown, with a clearance of 2½ ins. between the trucks. If necessary a 2-ft. gauge may be used, but this allows only a width of 2 ft. 6 in. for the truck, with the same clearance. The narrow and long truck, however, may be a blessing in disguise in the crowded shop.

IMPRESSIONS OF FOREIGN RAILROAD PRACTICE.

EDITORIAL CORRESPONDENCE.

(*Continued from page 175.*)

LONDON:

A man to become a locomotive runner in Europe must have had shop experience. On some roads he starts in the shop, then serves as fireman, and takes his place as "driver" in his turn. On others he fires first, then goes into the shop and qualifies as "driver." There seems to be no regular rule, but shop knowledge is nearly always necessary before a man is given charge of an engine. In France it is not unusual for young technical men entering railroad work to serve as firemen for an entire year in order to give them thorough knowledge of how locomotives are handled. They are told that they cannot learn anything on the road in a few weeks or months, and it is true. A young technical man who is now work manager on one of the leading English roads served six years in the shop and on the road before he was given any responsibility. Now he occupies a leading position in England and is well qualified to fill it.

English roads have "engine drivers." French roads have "mechanicians." We have "locomotive engineers." They are all supposed to be one and the same, but they are not.

Over here the "driver" or "mechanician" touches his cap and gives some attention when he is asked a question. This of itself might speak for a number of undesirable things; for example, it might be an evidence of servility or groveling or a sign of class distinction, but these men did not give me such an impression. I talked with a number of English "drivers" and also studied French "mechanicians" by aid of several friends. These men are brought up to treat an official with distinguished courtesy, and this fact is mentioned because it reflects light upon a difference between foreign and American practice. Organizations of labor are strong over here, but it is not necessary for the officials to devote a large proportion of their time to grievance committees. Those who employ labor in England have their troubles, and the labor organizations bring great pressure to bear in the way of "leveling influence," but with it all there yet remains an element in the situation which is very desirable. I refer to the fact that "engine drivers" must be good men in order to attain and hold their positions. Of course everyone will say that this is so the world over, but over here to be given charge of a locomotive means something, and the first anxiety of the man is to hold the job. To do this they must give a very high grade of service. They are held to strict account of the fuel given them, and they must be good men and remain good men or others take their places. The point is that the men are not the only ones who are making demands, and they are not the only ones to make grievances known. The company also has a grievance committee, which tends to make the standard of service high. This keeps the men busy to hold up their end of the burden. They are held to strict accountability. If the men who handle and fire locomotives first make sure that they are doing their work well, they are not likely to keep their grievance committees so busy. I believe that we ought to adopt coal premiums, paid in cash, and also cash premiums for perfection of service, all of which would tend to reward excellent service and also tend to make the difference between good and poor service perfectly apparent to the men through their pay envelopes. There is no difficulty in the way of our adopting premiums for engineers and firemen except properly organizing and carefully administering the system under competent direction. Foreigners have employed this system for years because their coal is expensive.

This high cost of fuel has an important bearing on locomotive practice abroad. In England it has led to keeping locomotives in more perfect condition than in any other country in the world. In Germany it has led to experiments in superheating, and in France it has resulted in locomotive design and construction without any regard to any question but that of producing the best locomotive which those who understand the conditions know how to build. The high cost of fuel has led to both scientific design and scientific operation of locomotives in Europe. We have the same reason for doing these things. Our fuel cost may average less per ton, but the amounts of the bills because of our heavy trains would stagger Europeans.

Some, but not all, locomotive superintendents over here take special pride in continuing locomotives in service which are 30 and 35 years old. They are poor weaklings, and new ones could be built for the cost of keeping them in repair. Englishmen, as a rule, insist upon the severest simplicity of construction in their locomotives. They have gone as far as they can now, and must face the question of complication very soon. They insist upon extra fine finish, both in the drawing room and in the shop. Take for example an English main rod. It is beautiful in proportion and is graceful in curves and in details. In the shop it is finished with equal care, and is a perfect mechanical job. It is always ready for the severest critics of international expositions. These things are overdone in England. They are a little underdone at home, and a position about one-third of the way between the two, beginning to measure from our end, would be about right.

English locomotives are works of art as to finish and painting. This is carried to a point far beyond justification on business principles, and it is only justified as far as it affects the quality of care in keeping the engines in condition. For example, a corner of the running board with a large fillet is much easier cleaned than are those with a sharp angle. An engine which is well painted is more easily kept clean than one that is rough. There is a great deal of expensive sentiment about the English locomotive. The traveller derives no comfort in a cold car from the fact that the engine is well finished, but it must be admitted that he is nevertheless very apt to go forward at a long stop, in order to have a look at the beautiful machine at the head of the train. Good fitting and good workmanship are always in order, but draw-filing, polishing and the refinements of the painter's art serve no essential purpose. The money would be better spent in other ways. The marine engineers of Great Britain are more practical in this respect. English boiler work is something to be unreservedly admired. Here is where perfection of fitting is absolutely necessary.

Our engines certainly have higher mean effective pressures in their cylinders than these. If it were otherwise these engines would be sadly overcylindered because their cylinders are so large. On the other hand, English engines of the inside connected type are very free in the exhaust. In many of them the valves may be seen through the exhaust pipe and stack. English engines have necessarily narrow ranges of power, and are built for the light work they do. We have shorter laps, greater lead and wider ranges of cut off.

I did not see a single English passenger engine which gave evidence that the front end had ever been hot, but not so with freight engines. Some results of tests were shown me indicating temperatures of 1,500 deg. F. in the smoke box. This was a 38-ton freight engine in coal service. It had 1,134 sq. ft. of heating surface, 18 by 26 in. cylinders, 20.5 sq. ft. of grate, 56 in. drivers, and carried 150 lbs. steam pressure. The maximum draft was 4 in. of water, and the mean 1.75 in. I was told that this little engine used 20.3 lbs. of coal per horsepower hour, and produced a maximum of 820 indicated horsepower with 40 per cent. cut off on a grade of 83 ft. per mile, at 23 miles per hour. On another trip with a load, including engine and tender, of 284 tons in 45 coal "wagons," the same engine indicated 441 horse-power at 36.5 miles per hour. In the best of these tests the rate of coal consumption ranged from 44.5 to 60 lbs. per sq. ft. of grate per hour. The water evaporated per sq. ft. of heating surface per hour varied from 7.78 to 9.09 lbs., and the water per indicated horse-power hour ran from 17.1 to 18.6 lbs.; the water per pound of coal from 7.7 to 10.8, and the maximum loads from 507 to 605 tons. The engine must have been efficiently handled to do such work.

G. M. B.

(*To be continued.*)

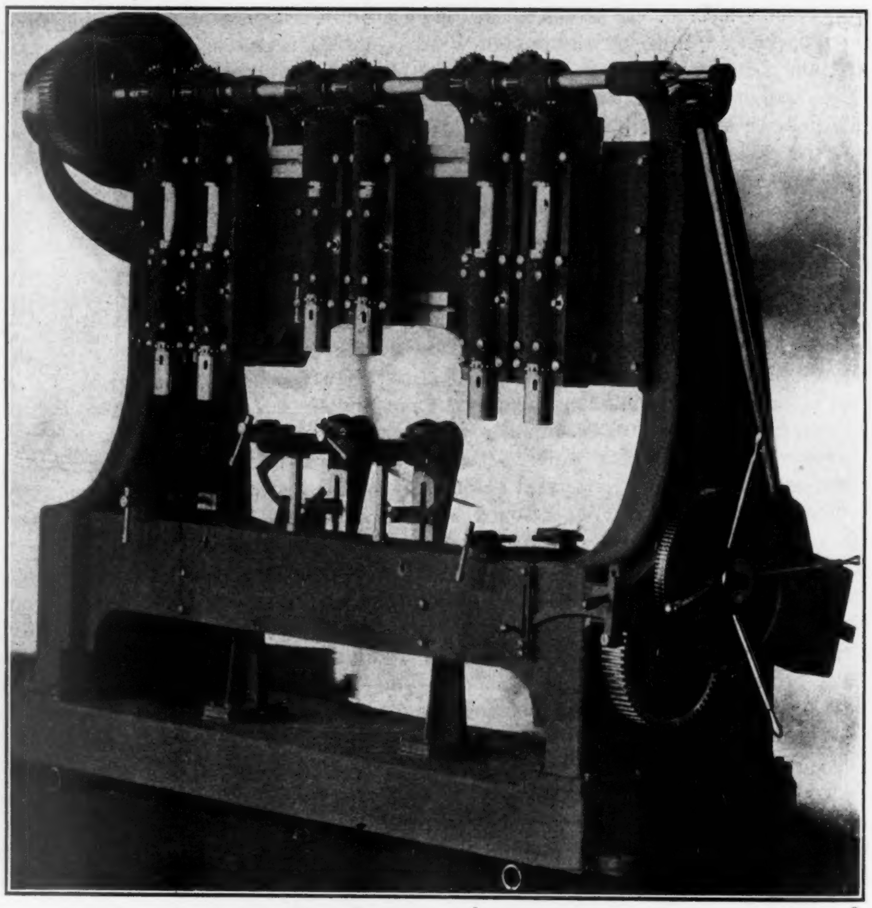
STANDARD ARCH BAR DRILL.

This machine, manufactured by Messrs. Foote, Burt & Co., Cleveland, Ohio, is specially designed for railroad shops for building arch bar trucks. It combines rigidity and convenience in operation.

The uprights are of box form and very heavy, with the metal distributed to give the greatest stiffness at the point of greatest stress. The cross-rail is of solid web construction, cross girted to withstand the upward thrust from the drills and resist all tendency to twist. Absolute absence of deflection under the heaviest cuts was the aim in the construction of the entire machine. The spindles are driven by forged steel miter gears with planed teeth, 8 ins. diameter, 4 pitch. Stiffness of the driving shaft is not depended upon for holding the driving in mesh with the driven miter, as the driving miter is securely housed in a bearing which is a part of the spindle head, securing this gear not only in its mesh with the spindle gear, but it is self-contained with the head and moves along the shaft when the head is adjusted for different centers of drills.

The table is fed up by means of rack and pinions, the feed shaft being 2¾ ins. in diameter, the feed racks having 3-in. face, 4 pitch, both the rack and pinions being of forged steel. Positive and very powerful feeds are provided, rendering the work smooth and steady in cutting. This adds to the capacity for work which can be done without regrinding the drills. An automatic knock-off is provided, which knocks off the feed at any point. A quick return is provided for its table, operated by means of the pilot hand-wheel at the right hand end of the machine. All the spindles are adjustable vertically for a distance of 5 ins. in order to permit the use of drills of unequal length, and this also permits the height of the drill points to conform to different offsets in the top and bottom arch bars. This adjustment is made by means of a rack and pinion in each head, moving the spindle up or down easily and quickly to the desired point, where it is quickly clamped.

In the engraving the convenient clamps for the arch bars are clearly shown.



STANDARD ARCH BAR DRILL, FOOTE, BURT & CO.

Liberal Attitude of a Labor Union.—Grand Chief Stone of the Brotherhood of Locomotive Engineers recently gave utterance to one of the most liberal and far-seeing policies which has yet emanated from any labor union leader. In speaking at a meeting of labor representatives in Fort Worth, Tex., he stood squarely for the "open shop." He stated that he was a "firm believer in union labor and the right of laboring men to organize," but held that it was unwise and unjust to form an organization and to compel a man to join it against his will, this being an interference with the personal liberty guaranteed by the Constitution of the United States. He attributed the fact that the railway labor organizations stand head and shoulders above others to the fact that they do not oppose the "open shop," and said: "On almost every road in the country we work side by side with men who do not belong to our orders. No man is forced to join us. We try to show him how he would be benefited by belonging to us, and where his interests are, but we never say to him to join us or you cannot earn an honest living by working here. I do not believe any man ever made a good member in any organization who was forced to join it against his will, for the chances are that when opportunity offers he will prove a traitor and betray you."

Logarithms for Beginners, by C. M. Pickworth. D. Van Nostrand Company, 23 Murray street, New York, 1904. Price, 50 cents.

The purpose of this little book is to present a more detailed and practical explanation of logarithms and their various applications than is to be found in text books on algebra and trigonometry. The author intended to assist the beginner by giving him a safe grasp of the underlying principles of this method of calculating, which he usually does not get in the usual methods of attacking the subject. The author intends the book to meet a need which has arisen in the latter developments of thermodynamics as applied to the electrical, physical and mechanical sciences. The book is intended as a simple introduction to the subject. Those who are accustomed to using logarithms will be very glad to have this book upon their shelves, and those who are making a study of the subject will find it a very valuable treatise.

Train Rules and Train Dispatching. A practical guide for train dispatchers, engine-men, trainmen and all who have to do with the movement of trains. By H. A. Dalby. First edition. Published by the Derry-Collard Company, 256 Broadway, New York, 1904. Price, $1.50.

The author of this book has been engaged in train dispatching for years and is still in active service. The book is heartily endorsed by Mr. John F. Mackey, of the Train Dispatchers' Association, who is the author of the introduction. The book is practically a textbook upon the work of a train dispatcher, and is a valuable treatise on the handling of trains. It follows and explains the work of the American Railway Association in systematizing the operation of trains through the standard time and standard code of train rules. It discusses time tables, divisions, districts and terminals, classes and rights of trains, train orders, types of train order signals, the relation between the dispatcher, engine and trainman, gives suggestions to young dispatchers, and presents the standard code of the American Railway Association. It will be particularly valuable to operators who desire to become dispatchers, to engine-men, trainmen and others who have to do with the operation of trains. The book is well printed and well bound, which is something unusual in works of this character.

JOINT MEETING OF INSTITUTION OF MECHANICAL ENGINEERS AND AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

This meeting, which opened in Chicago May 31, was unique in the assembling of over 900 registered attendants, and it was successful in every way. About 100 members of the English society were present. In the opening exercises Mr. J. Hartley Wicksteed, president of the Institution of Mechanical Engineers, represented that organization.

The papers covered a wide field, those of greatest interest to our readers being one by Prof. Goss on locomotive testing plants, and one by Mr. G. J. Churchward, of the Great Western Railway, of England, describing the interesting locomotive testing plant recently installed by him at Swindon, and one by E. A. Hitchcock, describing tests on a 2—6—0 locomotive on the Hocking Valley Railroad. Three excellent papers on steam turbines put that subject on record in a very satisfactory way, and Mr. J. T. Nicholson read an important paper on the work of machine tools.

The paper by Prof. Goss is both historical and descriptive. Credit for the idea of stationary locomotive plants is given to M. Borodin, of the Russian Southwestern Railways. The paper describes the construction of the plants on the Chicago & Northwestern, at Purdue University, Columbia University and the Pennsylvania Railroad test plant at the World's Fair at St. Louis.

The paper by Mr. Churchward is presented in abstract in this issue. This plant is used for testing and also for "breaking in" locomotives, and the work done by the locomotives is partially absorbed by an air compressor operated from the carrying wheels.

The road test of a freight locomotive on the Hocking Valley Railroad, described in the paper by Mr. Hitchcock, is the first record we have seen in which a heat balance for the boiler is attempted. The data are unusually complete.

A paper by J. T. Nicholson describes elaborate experiments with a lathe tool dynamometer, conducted for the purpose of determining not only the work done by the cutting tool, but also that of moving the slide rest during the cutting operations. The records involve over 300 tests, with from 50 to 100 separate observations in each. The construction of the apparatus is described and illustrated. In the discussion Mr. Wicksteed characterized the appearance of the new tool steels as constituting the greatest revolution that had taken place in his lifetime, and Prof. Benjamin considered the experiments recorded in this paper the most important ever made. We shall print portions of this paper in another issue.

The De Laval steam turbine was described in a paper by Messrs. E. S. Lea and E. Meden. Among the interesting points brought out was the construction of the wheel in such a way as to minimize the disastrous results in case of breakage because of centrifugal force. The rotating part is thinned at the rim to accomplish this. The authors stated that it was possible to use peripheral velocities as high as 2,100 ft. per second.

Mr. Francis Hodgkinson, in a paper entitled "Some Theoretical and Practical Considerations in Steam Turbine Work," described the Westinghouse-Parsons type, presented the ideal turbine element, and discussed the expansion of steam in this turbine. The author considered other types of turbine, but gave special attention to that with which he has been identified. He recorded elaborate tests, made at the Westinghouse works, and describes the testing department, giving important records taken from it.

A third paper on the steam turbine was read by Mr. A. Rateau. Like the others, this contained references to other types, but specially concerned the author's turbine, which has been quite successful abroad. This paper also dealt with marine turbines and turbine-driven centrifugal feed pumps for boilers and turbines for driving fans.

The meeting was both profitable and enjoyable.

PERSONALS.

Mr. J. H. Fildes has been appointed master mechanic of the Lehigh Valley, with headquarters at Buffalo, N. Y.

Mr. Thomas Coyle has been appointed master mechanic of the Lehigh Valley at Weatherly, Pa., to succeed Mr. J. H. Fildes, promoted. Mr. Coyle is promoted from the position of general foreman at Perth Amboy.

Mr. L. L. Bentley has been appointed mechanical engineer of the Lehigh Valley Railroad, with headquarters at South Bethlehem, Pa. He has for several years held the position of chief draftsman.

W. F. M. Goss, Dean of the Schools of Engineering of Purdue University, has received the honorary degree of Doctor of Engineering (D. Eng.), bestowed by the University of Illinois.

Mr. M. McGraw has been appointed master mechanic of the Illinois Central at East St. Louis, Ill., succeeding Mr. Isaac Rova. Mr. McGraw has been roundhouse foreman at Burnside, Ill.

Mr. W. P. Richardson has been appointed mechanical engineer of the Pittsburg & Lake Erie to succeed Mr. R. V. Wright, who has resigned to become associate editor of the American Engineer and Railroad Journal. Mr. Richardson is a graduate of the University of Minnesota, and entered railroad service as draftsman with the Chicago Great Western Railway. He became chief draftsman of that road, and went to the Pittsburg & Lake Erie as chief draftsman in 1902.

Officers of American Locomotive Company.—The valuable services of Mr. A. J. Pitkin in this company have been recognized by his election as president to succeed the late Mr. Callaway. Mr. J. E. Sague has been elected first vice-president, to succeed Mr. Pitkin, and Mr. Leigh Best has been elected third vice-president, in addition to his office of secretary. Mr. R. J. Gross retains the office of second vice-president. The executive committee has been increased from five to six, and Messrs. Frederick H. Stevens and William M. Barnum have been elected members of that committee. Mr. C. B. Denny retains the office of treasurer, and Mr. C. E. Patterson that of comptroller.

Mr. J. M. Wallis a year ago resigned as general superintendent of the Pennsylvania Railroad Division of the Lines East of Pittsburg on account of ill health and has not engaged again regularly in railroad service. He is, however, prepared to undertake in a consulting capacity investigations and reports upon railroad problems for which his education, professional ability and wide experience have eminently fitted him. Mr. Wallis was graduated from Stevens Institute of Technology in 1876 and the following year entered the service of the Pennsylvania Railroad, and continued upon its staff until 1903. He advanced through the various courses of the very thorough motive power training of the road, following which he was consecutively superintendent of motive power of the Philadelphia & Erie; Northern Central; Philadelphia, Baltimore & Washington, and the Pennsylvania Railroad grand division. After this he was for a time acting general superintendent of the Pennsylvania Railroad division, then general superintendent of the Philadelphia & Erie Railroad and Northern Central Railway. He then returned to Altoona as general superintendent of the Pennsylvania Railroad division. Mr. Wallis was one of the most successful motive power officials ever in the service of the Pennsylvania and, having also been equally successful as an operating officer, his opinions are of the greatest value to those who, in connection with the rapid progress of the time, are in need of expert professional advice in difficult motive power and transportation problems. Mr. Wallis may be addressed at Seldon Post-Office, Gloucester County, Virginia.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

MASTER CAR BUILDERS' CONVENTION.

The convention opened June 22 at the Grand Union Hotel, Saratoga, N. Y., with the largest attendance in the history of the association. After the usual formalities the association was addressed by Mr. H. H. Vreeland.

Speaking from the standpoint of one who had had a wide experience in steam railroad work and afterward in electric railroads, he referred to the introduction of electricity into heavy passenger service on the New York Central and Pennsylvania railroads in New York City, which presented a new problem to motive power men. This "revolution" in motive power would require a new character of experience in dealing with maintenance. Other "revolutions" had been gradual, on the order of evolution, but this was a substitution and a radical change in motive power which required more than expert carpenters' or blacksmiths' capacity. Referring to the extent of the new work, he said:

All your roads, and particularly those of these two great railway corporations that I have mentioned, as soon as they have installed electric traction in New York, will be handing over to their shops these new hybrid combinations, which are neither all cars nor all locomotives, but something of both, and it will take more than an expert carpenter or blacksmith to keep them in order.

For proof that I have not overstated the magnitude of the change under discussion, I fix here, in tabulated form, the total present electric generating capacity located at New York, so divided as to show at a glance the amount in operation at the present moment and that contracted for for near future delivery.

ELECTRIC GENERATING MACHINERY IN OPERATION OR CONTRACTED FOR TO TAKE PLACE OF STEAM LOCOMOTIVES IN VICINITY OF NEW YORK CITY.

	In Operation.		Contracted For.	
	K.-W.	Equivalent H.-P.	K.-W.	Equivalent H.-P.
Manhattan Railway	48,000	72,000	6,000	9,000
Brooklyn Elevated Lines	*20,000	30,000		
Interborough (subway)			48,000	72,000
L. I. Railroad			16,500	24,750
N. Y. C. Railroad			40,000	60,000
Total	68,000	102,000	110,500	165,750

* Estimated.

It will be noticed from this table that it is proposed to substitute for steam on the Interborough, the Long Island and the New York Central roads 156,750 h.p. units, or 54,750 units more than the Brooklyn elevated lines and the Manhattan Railway are at present developing. This all shows that within the next two or three years you are to have turned over to your care much of the machinery by means of which this tremendous volume of energy is to be translated into work, for adjustment on the vehicles you make and repair.

All this brings me to what, after all, is the most interesting element in the change, relating, as it does, to the individual worker. Academic and scientific men have done their work. Their problem has been solved—yours is yet to be.

The speaker counselled immediate steps in preparation, and brought the association face to face with the importance of the part the members must play in connection with the application of electric transmission to heavy transportation service. The speaker saw what successful long distance transmission meant to steam railroads. He desired to stimulate the ambition of his hearers to prepare for the new problem. He had found great difficulty in securing the right sort of men to deal with the problem presented by a large combination of street railways.

The presidential address of Mr. F. W. Brazier was a thoughtful presentation of the work before the association. A comparison of the problem of the master car builder of 37 years ago with that of to-day was drawn by contrasting a passenger car of the day of beginning of the association with that of to-day.

Thirty-five years ago the average coach would carry from 30 to 45 passengers and weighed about 14 tons; the cars were equipped with link and pin couplers; were carried on 4-wheel trucks with journals 3½ by 6 ins.; were lighted with oil lamps; had small windows; in some cases were without a clear story, and were heated

with wood-burning stoves. The cost of a coach such as I have described was about $3,500.

To-day our standard coach is 72 ft. long over end sills; weighs from 52 to 55 tons; has a seating capacity of 86 passengers; is carried on 6-wheel trucks, with journals 5 by 9 ins.; has steel platforms and wide vestibules; is heated with steam heat and lighted with gas and electricity. To-day a wide vestibule coach is worth in the neighborhood of $10,000.

In December, 1867, there were 289 locomotives, 386 passenger equipment and 5,530 freight equipment cars in the United States.

On June 30, 1902 (the latest figures compiled) there were 41,628 locomotives, 37,090 passenger equipment and 1,503,949 freight equipment cars in the United States.

In comparing the equipment in service on June 30, 1902, with that in service at the organization of the Master Car Builders' Association in 1867, it will be seen that the number of locomotives has increased 144 times, passenger cars 96 times and freight cars 272 times.

Of all the suggestions offered by Mr. Brazier one stood out very prominently, originating as it did with the president of the Master Car Builders' Association, viz.: the consolidation of the Master Car Builders' and Master Mechanics' Associations. The speaker took the position that there was no longer sufficient reason for maintaining separate organizations. This is the first time the consolidation has been proposed and supported by a presiding officer of the Master Car Builders' Association. The opinions expressed outside of the convention seemed to be generally favorable to the union, and it is believed that a wiser step could not be taken in the interest of the officers of the mechanical departments of railroads.

A summary of the suggestions of the president is as follows:

1. Adoption of a standard coupler.
2. Standardization of the pivot pin and material to be used in its manufacture.
3. Investigation of coupler side clearance.
4. A standard formula for journal bearings and linings.
5. Standard specifications for waste for passenger and freight equipment lubrication.
6. An addition to the requirements of standard brake-beams, calling for a transverse test of brake-beams.
7. Standardization of steel freight cars.
8. A study of the 40 and 50-ton capacity box cars from a commercial standpoint.
9. Improvements in uncoupling appliances on couplers.
10. Adoption of a standard arch bar truck.
11. The introduction of adequate apprenticeship systems.
12. The consolidation of the Master Car Builders' and Master Mechanics' Associations.

These recommendations were referred to the executive committee for action.

By the report of the secretary a total membership of 581 was announced, and the report of the treasurer showed a balance of $3,469.68 on hand in the treasury.

COMMITTEE REPORTS.

Supervision of Standards and Recommended Practices was the first report to be considered. No very vital changes were recommended. In connection with the subject of standards the association was addressed by Mr. Edward H. Mosely, secretary of the Interstate Commerce Commission, who wished to see the closest co-operation between the association and the commission in the matter of standards with respect especially to safety appliances. The speaker complimented the association upon the improvement in safety appliances brought about by its rules. He advocated the employment of two air brake pumps on locomotives employed in hauling long trains. In connection with the safety appliance law the speaker emphasized the purpose of the commission to see safety of railroad employees advanced to the utmost possible extent. Among the important problems for the future, necessity for improving the rules regulating the loading of lumber and other long materials was prominently mentioned.

Brake Shoe Tests.—There was no report on this subject. Dr. Goss stated that whereas no shoes had been submitted to the committee, a number of shoes had been tested at Purdue. This led to the question whether the association was content with the present status of the brake shoe question. After a brief discussion the standing committee was requested to make tests of new shoes which are now in use by its railroads.

Tests of M. C. B. Coupler.—This committee recommended submitting the following to letter ballot for adoption as standard and recommended practice of this association:

Standard.

1. Coupler limit gauge changed to conform to new contour lines adopted January 1, 1904, and to have raised figures "1904" cast upon same, superseding present gauge shown on M. C. B. Sheet 11.
2. Knuckle limit gauge changed to conform to new contour lines adopted January 1, 1904, and to have raised figures "1904" cast upon same, superseding present gauge shown on M. C. B. Sheet 11.
3. Change note on M. C. B. Sheet 11, "Pivot pin must be $13\frac{1}{2}$ ins. long from under side of head to center of hole for $\frac{3}{8}$-in. cotter pin, and must be either $1\frac{1}{2}$ or $1\frac{5}{8}$ in. in diameter," to "Pivot pin must be steel $1\frac{5}{8}$ in. in diameter of sufficient length to permit applying a $\frac{3}{8}$-in. cotter pin through the pin below the coupling lug" in order to conform to present specifications.
4. Change in coupler specifications to provide for single coupler jerk test.

Recommended Practice.

1. Worn coupler limit and wheel defect gauge, as shown on Sheet D, superseding the present worn limit coupler and wheel defect gauges.
2. Twist gauge changed to conform to new contour lines adopted January 1, 1904, and to have raised figures "1904" cast upon same, superseding present gauge shown on M. C. B. Sheet G.
3. Drop test machine.

A. Modifications and betterments in the detail design of the machine and the redesign to accommodate single coupler jerk test, shown in report of Proceedings for 1903.

B. Changes to provide for separate knuckle test, shown in Proceedings for 1903.

4. Separate knuckle test. Specifications for.

In the discussion Mr. Bentley (B. & O.) advocated machine fitting of the knuckle pins in order to secure better fits and reduce the amount of lost motion which resulted from the wearing down of roughness in fitting. This opinion was supported by other speakers. The recommendations of the committee were ordered submitted to letter ballot.

Standard Location of Third Rail for Electrical Operation.—This report was accepted without discussion. It is to be presented in another issue.

Stenciling Cars.—This committee was continued for report next year.

Coupling Chains.—The committee was continued to make a united report next year.

Air Brake Hose Specifications.—In addition to proposed new specifications this committee proposed arrangements between the association and Purdue University for the test of hose at the laboratory of the university in order to secure definite data under uniform conditions of testing. The committee was continued and the executive committee instructed to make the necessary arrangements for such tests. Mr. Sanderson stated that air-hose couplings would continue to be pulled apart in yards because of the delay attending the observance of rules for uncoupling by hand. He advocated $1\frac{3}{8}$-in. hose, and did not consider it advisable to use hose which was too expensive for commercial requirements. It was not desirable to use expensive hose, which was to be destroyed in a relatively short time by external injuries in service. The new specifications were submitted to letter ballot as recommended practice, the old specifications to be cancelled.

Draft Gear.—This committee recommended withdrawing the present "recommended practice" of the association because it has been outgrown. A spacing of 10 ins. between center sills of wooden cars and $12\frac{7}{8}$ ins. of steel cars was suggested. The committee recommended the abandonment of "continuous draft rigging." They suggested thicker followers, and recommended three designs of yokes for twin spring, tandem spring and friction draft gear, a standard which is badly needed. Mr. Hennessey wished to see the size of yoke rivets increased to

1⅝ in. in diameter, and to increase the width of yokes ½ inch. These suggestions were submitted to the committee on standards to report definite recommendations next year.

Stake Pockets.—This report is presented in abstract in this issue. It was referred to the committee on standards.

What Is the Best Preventive of Rust on Steel Cars?—This report is presented in abstract. Mr. West directed attention to the excellent staying qualities of white lead paints on steel cars. Mr. Hayward supported this from his experience, having noted that white lead lettering on steel cars usually stood out prominently even after the other paint on the cars had worn out. There was little desire on the part of the association to discuss the report.

At this point the following telegram was read by the president:

"At the annual meeting of the Central Association of Railroad Officers in convention assembled at St. Louis, the following resolution was unanimously adopted: Resolved, That this association urge upon the Master Car Builders' Association the fact that the use of so many types of automatic couplers is a serious detriment to the transportation departments of railroads, and that we strongly urge the association to adopt some type of vertical plane coupler, having a lock set, as standard. If one coupler cannot be agreed upon, that the number be increased, but not to exceed three or four.

"J. A. Gordon, *President*."

Outside Dimensions of Box Cars.—This committee had found it impossible to make substantial progress toward a standard car because of the variety of opinions covering framing. The report concluded with the following recommendations:

1. That the inside dimensions of box cars as approved by the American Railway Association, namely, 36 ft. long, 8 ft. 6 ins. wide and 8 ft. high, be submitted to letter ballot for adoption as standard.

2. For box cars on high trucks (4 ft. to top of floor):

	Ft.	Ins.
Height, top of rail to upper edge of eaves	12	6¾
Width at eaves, at above height, maximum	9	7

be submitted to letter ballot for adoption as standard.

3. For box cars on low trucks (3 ft. 6 ins.):

	Ft.	Ins.
Height, top of rail to upper edge of eaves	12	9¾
Width at eaves, at above height, maximum	9	7

be submitted to letter ballot for adoption as standard.

4. That the words and letters "Standard 12 ft. 6¾ ins. by 9 ft. 7 ins." be stenciled in 3-in. letters on the end fascia boards on all cars built to these dimensions.

These were ordered submitted to letter ballot.

Cast Iron Wheels.—This carefully considered report appears in abstract in this issue. The committee in the preparation of the report had conferred with the leading wheel makers and had secured their co-operation and assistance. Mr. Garstang presented the report, and stated that Mr. R. L. Ettinger, mechanical engineer of the "Big Four" railroad, had designed the wheels referred to in the report. This is considered the best report on wheels ever presented to the association, and was so characterized by a majority of the speakers in the discussion. Furthermore, the wheel manufacturers were a unit in support of the designs submitted by the committee. Mr. Waitt considered it remarkable that such cordial agreement could be had, and urged the adoption of these designs as recommended practice with a view of future advance to standards of the association. Mr. Muhlfeld (B. & O.) quoted the experience of ten years in support of the Baltimore & Ohio design of wheels, which differed materially from those of the committee. The discussion developed the fact that the Southern Pacific had used wheels like those of the report very successfully for several years. It was stated that flange breakages are not due to long continued action of the brakes, but to flange friction. This is an argument in favor of improved center plates and side bearings. Breakage of wheels was attributed to inequalities in braking, but Mr. Onderdonk (B. & O.) quoted tests indicating that wheels on which brakes had never been used had developed cracks in flanges. Mr. McIntosh believed these cracks to exist in the wheels when cast. He favored improved side bearings to relieve the flanges from friction. Mr. Muhlfeld reported favorable effect on flange breakage by the use of lateral motion trucks. The designs of the committee were ordered referred to letter ballot as recommended practice for a year's trial.

Revision of Rules for Loading Long Materials.—This year this report is of unusual importance because of a serious wreck which was caused last year by a load of lumber slipping off a car. It was voted to place the annual revision of these rules in the hands of a standing committee. The loading of ties on flat cars became prominent in the discussion, and it was decided to amend the rules as follows:

"Flat cars loaded with cross ties or fence posts will not be accepted for shipment."

The amended rules were referred to letter ballot.

Steam Line Connections.—This committee had found that some of the steam coupler manufacturers could not provide 1½-in. openings in the gaskets of couplers which they were making. Later it was found that some of them could do it. This complicated matters. It was thought necessary to establish a new contour because the dimensions furnished last year were not considered sufficient. There was also a question whether fixed or self-adjusting gaskets should be adopted. More time was required to settle the question. The committee was continued.

The Committee on Tank Cars was continued for another year.

Interchange Rules.—Mr. Sanderson proposed the adoption of the report of the arbitration committee as to changes in the rules as they stood, with the exception of the prices for repairs to steel cars, which was discussed separately. The motion was carried and, instead of hours and days of bickering over relatively small details, the interchange rules were disposed of in about 60 seconds. This really "took the breath" of the association. The arbitration committee made no radical proposals of changes and the rules, as to details, were practically eliminated from the discussion. No better exhibition could be given of the spirit of concord existing in the association this year, and the great confidence of the association in the arbitration committee was sufficiently indicated. It is to be hoped that this precedent will lead to entrusting the revision of the rules almost entirely to this judicial committee.

INDIVIDUAL PAPER.

"Use Of Steel In Passenger Car Construction," By William Forsyth.—The author's object was to direct attention to the great increase in weight of passenger cars, with a relatively small increase in capacity. The weight of passenger cars had increased about 5,000 lbs. per year for the past five years. He considered steel for frame construction, for lightness and increase of strength. Four designs of steel frame construction were included in the paper. In the discussion, Mr. Henderson referred to the safety features of steel frame cars in wrecks, and wished the association to consider fireproofing the woodwork of passenger cars. Mr. Barnum spoke of the use of steel in framing of postal cars. It was thought desirable that the association should advance steel frame designs as rapidly as possible in order to be in advance of the demand of the government in this service. Evidently the time for steel frame passenger cars has arrived. This subject was referred to a special committee for report next year.

TOPICAL DISCUSSIONS.

Advantages and Disadvantages of 2-in. Main Steam Pipes with 1⅝-in. Steam Hose.—Mr. Hennessey introduced the subject and asked for information. Mr. Ball stated that tests on 16-car trains made last winter indicated that 60 lbs. pressure sufficed in connection with 2-in. train pipes, whereas 80 lbs. were required with 1½-in. pipes, and the "Lake Shore" was fitting up with 2-in. train pipes. Reports from the New York Central were also favorable to the large pipes. Mr. McIntosh thought that 1½-in. pipe was sufficient after the steam was once brought to the rear of the train in heating up. Mr. Schroyer believed the pipe diameter to be less important than the large openings through the couplings. Mr. Ball wished to

see the pressure on the hose reduced by the use of larger train pipes. He had found larger openings through the couplings very satisfactory.

To What Extent Does Friction Draft Gear Reduce Repairs and Expenses?—Opened by Mr. E. B. Gilbert. From a wide experience he quoted a cost of 4¼ cents per car per year for friction draft gear on 6,800 steel cars from 1897 to the present time, and in very heavy service. Mr. Gilbert discussed the proper methods of comparing friction and spring gears. His remarks will be printed in full in another issue.

To What Extent Will a More Rigid Inspection of Car Couplers at Terminal Points Reduce Accident and Repairs?—Mr. Macbeth opened the discussion by stating that a large number of break-in-two accidents were due to worn couplers. He strongly recommended stretching trains at terminals and rigid inspection of the condition of the couplers, as to wear, by a small gauge which could easily be carried in the pocket of the inspector. This would indicate whether knuckles are worn sufficiently to uncouple on the road. He recommended the adoption of such a gauge by the association. This subject developed the fact that break-in-twos are increasing daily and that couplers are now allowed to run in very defective condition.

Advantages and Disadvantages of Different Varieties of Side Bearings.—Introduced by Mr. L. H. Turner. The speaker stated that side bearings of the best construction would not suffice if the center-plates were not right. He advocated the use of frictionless side bearings with frictionless plates and properly constructed body bolsters. His remarks will be printed later.

Cannot the Present Method of Securing Coupler Yokes to Couplers for Freight Cars Be Improved.—Mr. Ball offered a design of a coupler yoke with a hinged connection between the coupler shank and the yoke. This would provide means for quick repairs by using a detachable yoke at interchange points. It would also provide lateral motion for couplers. The subject was referred to the executive committee for consideration next year.

Brake Beams, Proper Hanging of, to Secure Brake Shoe Clearance.—Opened by Mr. W. E. Fowler. The proper support for brake beams was from the trucks, so that they would not be affected by the springs. Long hangers were desirable, and they should have such angles as to cause the brake shoes to drop away from the wheels. Inside hung brakes were strongly advocated, both for passenger and freight cars. It was most important to obtain uniform piston travel, which was impossible if brake shoes were hung to the car bodies.

Stronger Draft Gear for Passenger Cars.—Introduced by Mr. H. La Rue. The shocks of heavy locomotives in starting heavy trains constituted an important problem. Mr. Henderson stated that with trains of 15 to 18 cars on the Santa Fe the ordinary draft gear was too weak and permitted the buffers to separate as much as 2 ins. Increased spring capacity was suggested as a remedy. Mr. Hennessey advocated friction draft gear as the ideal draft gear for passenger cars. Increasing spring capacity alone gave too much recoil. Excessive shocks should be received by frictional resistances. Mr. Herr stated that this was easy to accomplish providing sufficient space is available.

The officers for the year were elected as follows: President, W. P. Appleyard; first vice-president, Joseph Buker; second vice president, W. E. Fowler; third vice-president, G. N. Dow; treasurer, John Kirby; executive members, James McBeth, A. E. Mitchell and H. D. Taylor.

The retirement of President Brazier was made impressive by the presentation of the ex-president's medal by Mr. George A. Post in a remarkably fitting and worthy manner.

The convention was unusually satisfactory and successful. Businesslike conduct of the meetings and prompt, brisk discussion characterized them throughout.

MASTER MECHANICS' ASSOCIATION.

President W. H. Lewis called the convention to order June 27, the attendance being nearly as large as that of the Master Car Builders' Convention. The presidential address was an important contribution to current literature on the subject of motive power problems. Throughout, the speaker urged the members of the association to studiously consider not only the problems of the present, but to prepare for those which are to come. Special prominence was given to the influence to be introduced by electricity into motive power questions in the future. As to present problems, he laid particular stress upon the tendency to overload and overwork locomotives. In this connection he traced the development of the locomotives on the Norfolk & Western Railway, and referred to the table which was printed on pages 224 and 225 of our June number. This revealed a surprising extent of progress. One effect of the address, if it receives the attention it deserves, will be to cause a more careful study of locomotive operation looking toward more rational loading. The address is a paper for general managers as well as motive power officers. Locomotive failures constituted an operating as well as a motive power problem. The speed of trains had much to do with the so-called "failure of the big locomotive." The speaker recommended for consideration next year the following subject:

"What are the practices underlying the proper loading of locomotives on the basis of conducting transportation, with the greatest efficiency at the least cost, considering all the factors individually?"

The AMERICAN ENGINEER tests and the proposed consolidation of the two associations received the support of the president.

A total of 791 members was stated in the report of the secretary. Last year the total was 751; 96 had been added during the year and the loss by all causes was 56. The treasurer's report showed a balance of $2,874.80 in the hands of the treasurer.

The proposed change in the constitution concerning representative membership was discussed, the purpose of the new membership to be appointed by railroad officials being to represent the roads in connection with scientific investigations conducted by the association and also in the adoption of standards. The amendment was passed. This subject will be referred to in a future issue.

COMMITTEE REPORTS.

Ton-Mile Statistics. Credit for Switch Engines.—This report appears in abstract in this issue. Mr. McIntosh called attention to the fact that many road engines were in switching service, and that the weight on drivers would not always give a fair ton-hour unit. He recommended using the adhesive weight of the locomotive. The recommendation of the committee was accepted with the proposed change as to adhesive weight and the matter was referred as a recommendation to the American Railway Association.

Coal Consumption of Locomotives.—Mr. H. T. Herr presented the report. He stated the desirability of a standard method of employing locomotive engineers and firemen and that the committee did not favor pooling of engines. Tests were recorded showing that the efficiency of locomotives as a whole had improved materially since the advent of large grates and heating surfaces. The "large locomotive" was shown to be highly advantageous from an operating standpoint. Grate area should be determined by a favorable rate of combustion. The most important observation of the report was the necessity for better methods of recruiting engineers and firemen and increasing their efficiency. In the discussion the bad effects of pooling were made prominent. The difficulty in securing satisfactory firemen was spoken of as serious. Good men could not be had. Mr. McIntosh believed the automatic stoker to be the only solution of the fireman problem. Mr. Barnum believed it necessary to arrange cab fittings more conveniently in order to aid firemen, particularly on large engines. He supported the automatic stoker, and urged investigation and de-

velopment of this device. Mr. Walsh (C. & O.) thought that the passing of the control of engineers and firemen from the motive power to the operating departments had more to do with decreased efficiency of these men than pooling. Dr. Goss called attention to the fact that the committee did not speak enthusiastically of the large grate. Large grates required greater skill in firing. The discussion centered in the fireman question, and it became obvious that some important questions have been neglected in the development of big locomotives. Mr. McKeen (Union Pacific) emphasized the importance of good fuel records, which would bring the statistics before the individual firemen. He thought that "we ought to get after the coal chutes" and instal proper weighing devices for coal. This report was distributed too late for proper discussion.

Locomotive Front Ends.—Mr. H. H. Vaughan, chairman of the committee, explained the present standing of this question (The complete report appears elsewhere in this issue.), and the fact that the question to be decided was whether or not the association would provide funds for pursuing the tests. Mr. Vaughan moved that the executive committee be instructed to furnish funds for the tests when money is available. Carried.

Locomotive Driving and Truck Axles and Locomotive Forgings.—This subject was presented by Mr. Pomeroy, who explained that it was a report of progress in co-operating with the American Society of Mechanical Engineers, American Institute of Mining Engineers and the American Society for Testing Materials. It was stated incidentally that by the use of a new drill, test pieces may be cut from the ends of an axle without weakening the axle and without requiring the use of coupons. In the discussion Mr. Gillis considered it necessary to drill the full length of axle in order to insure the discovery of cavities in the metal if any existed. Mr. Walsh (C. & O.) stated that manufacturers would not give any guarantee whatever of freedom from "piping" unless axles are drilled. In view of this it was desirable that the committee should consider this factor. The committee was continued.

Boiler Design.—Dr. Goss presented this important report, which appears in abstract in this issue. The committee recommended laboratory tests for the determination of the rapidity of circulation in a boiler generating varying amounts of steam. It was shown that there was a great lack of definite information with respect to boiler design. Mr. Waitt proposed a resolution empowering the executive committee to raise a fund of $5,000, to be used under the direction of a special committee, for the purpose of conducting such tests. The resolution was passed.

Revision of Standards.—One of the important subjects this year was the revision of the specifications for firebox and boiler steel, which had not been revised for ten years. The committee recommended bringing the specification up to date to correspond with those of the American Society for Testing Materials. The proposed specifications for firebox and boiler steel were ordered submitted to letter ballot for adoption. This was a new departure for this association, but the subject was considered too important for less deliberate action. The proposed specifications for boiler tubes were similarly disposed of.

Piston Valves.—Mr. McIntosh presented the report, which contained records of elaborate tests for tightness of piston valves, conducted on the Norfolk & Western and "Lake Shore" railroads, which indicated surprising losses by leakage of piston and slide valves; one case recorded a loss of 2,880 lbs. of steam per hour. The best piston valve showed a leakage of 268 lbs. per hour, and the best slide valve 348 lbs. per hour. Piston valves leaked less than slide valves. This important report will be referred to in another issue.

Automatic Stokers.—Mr. J. F. Walsh in presenting the report spoke of the development of the automatic stoker and referred to the economic advantages of the device. It greatly reduced the work of the fireman. Reduction of repairs and regularity of service were also important. Stokers were most valuable on long firebox engines, hauling heavy trains over long divisions where the ordinary firedoor would be open two-thirds of the time. By proper manipulating, the stoker referred to in the paper could be increased 100 per cent in capacity. Dr. Goss believed that a large increase in efficiency should not be expected from locomotive stokers. A locomotive stoker must be able to respond instantly to sudden variations of load. It should be considered as an automatic shoveller as distinguished from stationary types. The stoker referred to in the paper was of the type from which success may be expected in locomotive practice. This stoker certainly did get coal into the firebox and it also distributed it uniformly. Those interested in the development of stokers should be greatly encouraged by this discussion to make renewed efforts toward the production of a satisfactory design. Mr. Walsh said that this stoker would spread coal evenly over the floor of a room which was 10 by 14 ft. in size, showing that it will easily take care of wide fireboxes. Mr. Forsyth thought that the thing to do was to put the present stoker to work without waiting for further development. Mr. H. T. Herr did not believe automatic stokers would save coal because of the necessity for using steam for its operation. Neither would stokers fire better than good men but the strong point of the stoker was its endurance. The stoker required about 300 lbs. of steam per hour. Dr. Goss believed that stokers would permit of using cheaper coal on locomotives as they had in stationary practice. This was one of the most, if not the most, important subject before the convention in its bearing upon the capacity of locomotives and repairs on fireboxes. In fact, whenever the fireman and firing were mentioned the discussion became very lively, indicating that everyone was deeply interested and greatly troubled in the matter of firing large locomotives.

Locomotive Frames.—Mr. L. R. Pomeroy, who had assisted the committee, was requested to present the report which was chiefly concerned with the question of frame breakage on large locomotives. A large number of frame designs were included in the report. These had been submitted to the leading steel foundrymen and specifications suggested by them were included. The report also compares wrought iron with cast steel. The latter material was strongly advocated by the committee, because of its strength and the fact that the frames were made all in one piece. Sensible design and suitable frame bracing were strongly urged. Mr. Pomeroy spoke favorably of the plate type of frames. Proper drainage of cylinders had an important influence on frame breakage. In the discussion Mr. McIntosh advocated construction which would reduce to a minimum the number of frame bolts. Mr. Vaughan described experiments which he conducted (on the L. S. & M. S. Ry. See American Engineer, January, 1904) for the purpose of studying frame deflections. Water in the cylinder had produced actual stretching of large binder bolts, which led to fractures. Piston valve engines with single front frames required pedestal binders which positively would not stretch. The "clip" binder was generally considered by several speakers as better than the bolt binder.

Cost of Locomotive Repair Shops.—Mr. Soule explained the objects of the committee in its report and the reasons for the selection of the units used. The report was the only one which was received with applause. Mr. Barnum expressed the opinion that it was one of the most valuable ever brought before the association. It will be printed in full in this journal.

INDIVIDUAL PAPERS.

Grates for Bituminous Coal.—By J. A. Carney. This paper suggested doing away with dead grates entirely and that no drop grates be used unless they can be shaken. It also recommended 50 per cent. of air openings in grates, and that ash pans should have air openings of at least 25 per cent. of the grate area. Mr. Carney explained that the grate recommended in the report had been in successful use for 18 months. Mr. Player thought that the area of air openings under grates should be based on the flue area rather than the grate area. The grate referred to in the paper received favorable comment in the discussion.

Improved Tool Steels.—By Mr. W. R. McKeen. Tests of tool steels were described in this important paper, which should be placed before every railroad shop foreman. The comparisons were well drawn and the impression was made that special care is desirable in introducing the new tool steels in order to get

the utmost out of them. In the discussion several speakers preferred other than "high-speed" steels for finishing cuts because of cost and smoother finish. Messrs. Seley and McIntosh spoke of the economic advantages of using holders and relatively small pieces of alloy steel rather than tools made from the bar.

Variable Speed Motors.—By Mr. C. A. Seley. This paper will be printed in this journal. It chiefly concerns tests made upon motor-driven machine tools and is a valuable record supplementing the report of the committee on this subject last year.

Technical School Graduates.—By Mr. R. D. Smith. The object of the author was to make suggestions looking toward a system which would retain them in railroad service. The paper appears in abstract in this issue. As usual, apprenticeship brought out a lively discussion, in which higher pay was urged as a necessity. Mr. McIntosh did not approve of regular courses of shop experience, preferring "to turn the boys loose in the shop to make their own way." One speaker referred to the objection to special apprenticeship on the part of labor organizations. Mr. Johnson (Canadian Pacific) cautioned the association against administering special apprenticeship in such a way as to discourage the regular apprentices. Mr. Walsh believed that men should be paid what they are worth without regard to whether they are technical school graduates or not. The discussion was disappointing, not a single new idea being mentioned.

Terminals for Locomotives.—By R. Quayle. This paper was received too late for advance distribution. It is an excellent review of the locomotive terminal problem, and discusses the factors in detail, laying special stress upon adequate facilities, and should be thoughtfully read by every operating official. Mr. Bentley, who presented the paper, did not know of a properly ventilated roundhouse.

TOPICAL DISCUSSIONS.

Grease Lubrication.—Favorable experience with the use of grease for driving boxes was reported by every speaker. It is evident that grease lubrication is an improvement over oil and the change seems to be likely to be permanent. Several speakers stated that hot driving boxes had been practically entirely overcome. Some trouble had been experienced, but they had been from mechanical defects. An important and necessary feature of grease lubrication was a continual pressure of the grease against the journal, as in the practice introduced by Mr. Elvin and known by his name.

Advantages of Screw Reverse Gear for Locomotives.—Mr. John Player (American Locomotive Company) introduced the subject with a statement of the disadvantages of screw gears. They occupy more room and are more complicated than lever gears. With piston valves there was no need of anything more powerful than a lever, and the speaker thought the lever gear good enough. Opinion was quite generally in favor of the lever, but several speakers believed it necessary to provide power reverse gear (either steam or air) for the largest engines. Others directed attention to the advantages of a lever whereby the condition of lubrication of the valves could easily be ascertained.

Air Spaces Under Grates.—Mr. F. J. Cole stated that there could hardly be too much space for air to enter ash pans. It was often difficult to obtain sufficiently large openings in the front and back ends of ash pans. As much opening as possible should be provided in front. The total air openings should not be less than 75 per cent. of the total flue openings. The discussion developed the fact that many locomotives have insufficient air openings. Mr. L. R. Johnson considered it desirable to supply ash pan openings equal to the tube area, as the area could easily be reduced if desired. Mr. West, however, spoke of excellent results with engines fitted with the Gates fire-door, with an opening 8 by 12 ins., which was never closed, this being the only entrance for air. Mr. Player supported Mr. Cole's recommendation as to large openings. Dr. Goss showed that any constrained area in the passages for gas or air required increased the work of the exhaust jet. The ash pan openings were easily controlled, and he believed that these openings should not be restricted. The ideal condition would be to avoid ash pans altogether.

Painting Locomotive Front Ends.—Mr. W. O. Thompson quoted satisfactory experience with Walker's smoke-stack black, thinned with Sipe's Japan oil in proportions of one part of Japan to two parts of stack black. Mr. Walsh recommended graphite for this purpose. Mr. Chase had found graphite, white lead and boiled oil to be the best paint. It cost 9 cents to apply one coat. No two speakers recommended the same thing.

Comments on three other topical discussions will be reserved until next month.

At the conclusion of the discussions Mr. Seley presented a proposed amendment for action next year. It provides for a committee of executive members similar to that of the Master Car Builders' Association.

The election of officers for the coming year resulted as follows:

President, P. H. Peck; first vice-president, H. F. Ball; second vice-president, J. F. Deems; third vice-president, Wm. McIntosh; treasurer, Angus Sinclair.

Out of a voting membership of over 700 only 47 votes were cast in the election of officers.

In an eloquent address Mr. George A. Post presented to the retiring president, Mr. W. H. Lewis, the medal which, through a pleasing and unique custom, is conferred by the Supply Men's Association each year. The convention then adjourned.

The *Railroad Gazette*, after nearly 50 years of publication in large form, appeared June 17 with leaves measuring 13 by 9¾ ins. While some criticism may be offered because the dimensions are not "standard," it is evident the purpose of the publishers was to turn out a paper decidedly attractive and easily readable. In this they have succeeded admirably. One important reason for changing the size and makeup of the *Railroad Gazette* is given in an announcement of the publishers that they have bought *Transport*, the leading railroad paper of England and the Colonies, and beginning July 8 will print in London under the name *Transport and Railroad Gazette*, an international edition of the combined papers.

Mr. A. H. Fetters has been appointed mechanical engineer of the Union Pacific Railway with headquarters at Omaha, Neb. Mr. C. B. Smyth has been appointed assistant mechanical engineer to succeed Mr. Fetters.

The B. F. Sturtevant Company.—This company announces the removal of its entire plant from Jamaica Plain to the new works at Hyde Park, Mass., where nine acres of floor space and every modern appliance put them in position to manufacture its well-known products more advantageously than ever before.

The Garrett Interlocking Draft Arm was exhibited at the Saratoga convention. It was developed by M. A. Garrett of the Farlow Draft Gear Company and is made in cast steel or malleable iron. These arms are connected to the bolster by dove-tailed joints and they completely fill the space between the bolster and end sill. Space sufficient for any draft gear is provided. These draft arms protect the center sills and bring the pull of the draft gear upon the body bolster. The center pin must be sheared and bolster cocked before the center sills can be injured.

Oil cabinets with adjustable measuring devices were exhibited at the Saratoga conventions by S. F. Bowser & Co., Fort Wayne, Ind. These cabinets are very convenient for roundhouses and shops where oil of any kind is used. The cabinets are of various sizes and styles. By means of a pump lever exactly the desired quantity of oil is pumped from the storage tanks. A special cabinet as constructed for the engine rooms of naval vessels was exhibited. A large number of cabinets have been supplied to leading railroads for shops and roundhouses. They are also very convenient in the engine rooms of power houses.

Carey's Magnesia Coverings are described in a pamphlet issued by the Philip Carey Manufacturing Company, Lockland, Ohio, which treats briefly of the subject of heat insulation and magnesia coverings and illustrates a number of excellent applications. This company was represented and exhibited at the Saratoga convention. Their products are specially prepared for locomotive and other railroad uses.

TABULAR COMPARISON OF NOTABLE RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO TOTAL WEIGHTS

PASSENGER LOCOMOTIVES.

Type—Drivers	4-6-2	4-6-2	4-6-2	4-4-0	4-4-2	4-6-2	4-4-2	4-4-2	4-4-2
Type—Name	Pacific	Pacific	Pacific	Oil-burner Atlantic	Atlantic	Pacific	Vauclain Bal. comp.	Atlantic	Atlantic
Name of railroad	C. & A.	N. Y. C.	A.,T.&S.F.	S. P. Ry.	N. Y. C.	C.,R.I.&P.	C., B. & Q.	Santa Fe	C. & A.
Number of road or class	602	2799	1200	3022	3000	801	2700	287	553
Builder	Baldwin	American	Baldwin	Baldwin	American	American	Baldwin	Baldwin	Baldwin
Simple or compound	Simple	Simple	Simple	Vauclain Compound	Cole Bal. Compound	Simple	Compound	Vauclain Compound	Simple
When built	1904	1904	1903	1903	1904	1903	1904	1903	1903
Weight engine, total, pounds	221,500	215,000	215,180	200,030	200,000	192,800	192,000	187,000	183,820
Weight on drivers, pounds	135,110	141,000	140,800	102,190	110,000	130,000	100,000	90,000	103,690
Weight on leading truck, pounds	40,500	36,000	27,680	61,120	50,000	....	50,000	52,000	40,130
Weight on trailing truck, pounds	45,490	38,000	46,700	36,200	40,000	....	42,000	45,000	40,000
Weight of tender (loaded), pounds	166,600	127,000	....	....	121,600	....	....	....	166,600
Wheel base, driving, feet and inches	13-4	13-0	13-8	6-10	7-0	12-4	7-3	6-4	7-8
Wheel base, total, feet and inches	33-4	33-7½	33-9½	31-3½	27-9	31-10	30-2	29-6	27-0
Wheel base, total, eng. & tender, ft. & in.	62-8¾	59-0	62-10½	65-5¼	53-8	58-9	....	58-3½	56-3½
Driving wheel, diameter, inches	77	75	69	79	79	69	78	73	80
Cylinders, diameter inches	22	22	22½	15 & 25	15½	21	15 & 25	15 & 25	20
Cylinders, stroke, inches	28	26	28	28	26	26	26	26	28
Heating surface, firebox, square feet	179	178.65	122.8	155	175	164	166.4	190	191.2
Heating surface, arch tubes, square feet	....	27.35	....	....	23	....	....	....	....
Heating surface, tubes, square feet	2,874	3,570	3,402	2,883	3,248.1	2,940	3,050.5	2,839	3,056
Heating surface, total, square feet	3,053	3,776	3,595	3,038	3,446.1	3,104	3,216.9	3,029	3,247.2
Firebox, length, inches	108	96⅛	108	121	96⅛	84	96⅛	107 15-16	108⅛
Firebox, width, inches	66	75¼	71¼	63⅜	75¼	74	66¼	66	72¼
Grate area, square feet	49.5	50.23	53.5	....	50.23	42.2	44.14	49.4	54.2
Boiler, smallest diameter of, inches	70	72 1-16	70	66	72¼	66⅛	64	66	70
Boiler, height, center above rail, ft. & in.	9-5	9-5	....	....	9-3 1-16	....	....	....	9-5
Tubes, number and diameter of, in inches	245-2¼	303-2¼	290-2¼	346-2	390-2	300-2	274-2¼	273-2¼	326-2¼
Tubes, length, feet and inches	20-0	20-0	20	16	16	18-7	19	....	16
Steam pressure, pounds, per square inch	200	200	220	200	220	200	210	220	200
Type of boiler	Straight	Straight	Wagon top	Wagon top	Straight	Wagon top	Wagon top	Wagon top	Straight
Fuel	Bitum.	Bitum.	Bitum.	Oil	Bitum.	Bitum.	Bitum.	Bitum.	Bitum.
Reference in AMERICAN ENGINEER AND RAILROAD JOURNAL.	Apl., 1904 P. 133	Mar., 1904 P. 87	Dec., 1903 P. 443	Sept., 1903 P. 329	May, 1904 P. 184	Oct., 1903 P. 351	June, 1904 P. 212	June, 1903 P. 212 Sept., 1903 P. 334	Dec., 1903 P. 458

Note.—This table supplements that presented in this journal as an inset in June, 1908.

MOTOR-DRIVEN MACHINE TOOLS.

APPLICATIONS TO SPECIAL MACHINERY.

Under this heading in our May issue a number of special applications of motors to machine tools were presented, and the accompanying five engravings show others of equal interest.

Fig. 1 illustrates a motor-drive applied to a more highly specialized class of tool, this being the recently re-designed 50 by 10-in. automatic gear-cutting machine, with automatic worm hobbing attachment, built by Gould & Eberhardt, Newark, N. J. The motor, which is a Lundell direct-current motor, is most conveniently mounted upon an extension of the base at the rear out of the way, and drives direct through gearing. The switch and starting box for operating it are conveniently mounted upon a stand at the rear, so that the tool, while self-contained, is very compact.

FIG. 1.—AUTOMATIC GEAR CUTTING MACHINE, WITH SELF-CONTAINED MOTOR DRIVE.—GOULD & EBERHARDT.

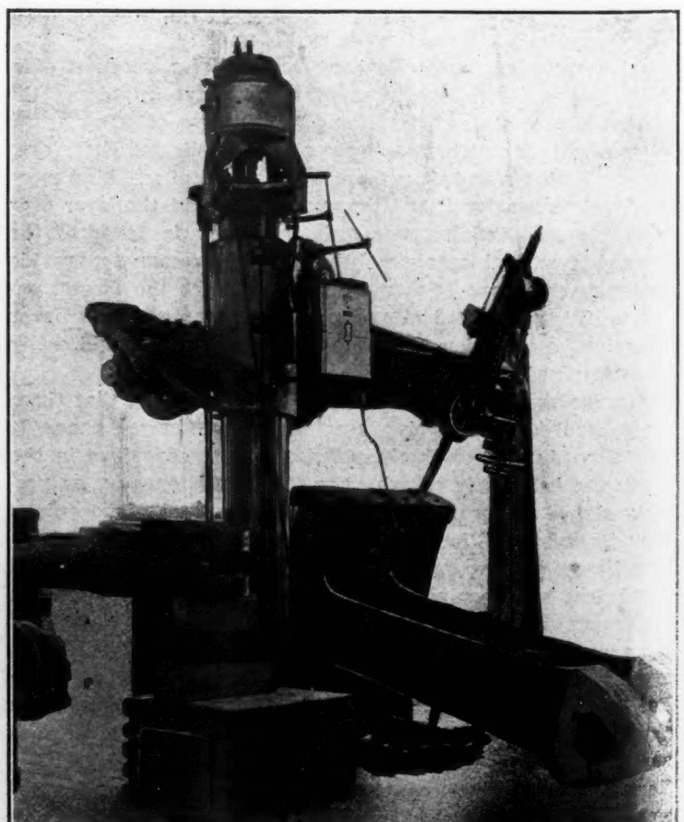


FIG. 2.—SPECIAL NILES PORTABLE FLOOR PLATE DRILL, WITH DIRECT VERTICAL-MOTOR DRIVE; AT THE WORKS OF THE BULLOCK ELECTRIC MFG. COMPANY.

TABULAR COMPARISON OF NOTABLE RECENT LOCOMOTIVES

ARRANGED WITH RESPECT TO TOTAL WEIGHTS

PASSENGER LOCOMOTIVES. FREIGHT LOCOMOTIVES.

4-4-2	4-4-2	4-6-0	4-4-2	4-4-2	2-6-4	0-6-6-0	2-10-0	2-8-0	2-8-0	4-6-0	2-8-0	0-8-0
Atlantic	Atlantic	10-wheel	Atlantic	DeGlehn Comp.	Suburban	Mallet Comp.	Tandem Comp.	Consol.	Consol.	Comp. S.-heater	Consol.	8-wheel switcher
Wabash	Vandalia	D. & H. Co.	P.&L.E.	Penna.	P. & R.	B. & O.	Sante Fe	L.S.&M.S.	N. Y. C.	Can. Pac.	Erie	C. & O.
620	51	502	305	2512	381		915	Class C	2498	1300	H.-12	8
American	American	American	American	Soc. Als.	Baldwin	American	Baldwin	American	American	American	American	American
Simple	Simple	Simple	Simple	Compound	Simple	Compound	Compound	Simple	Simple	Compound	Simple	Simple
1903	1904	1903	1903	1904	1903	1904	1903	1903	1903	1903	1900	1904
180,700	179,000	175,000	168,000	160,000	201,700	334,500	287,240	228,000	220,200	192,000	189,400	171,175
96,700	109,500	131,500	96,000	79,500	120,860	334,500	234,580	202,900	200,000	141,095	165,900	171,175
46,000	....	43,500	....	46,500	19,120	....	23,420	....	20,200	50,925	23,500	....
38,000	....	....	....	34,000	61,720	....	29,240	....	....	....	....	....
130,000	....	120,000	145,000	132,500	....	143,000	....	148,000	137,500	122,000	126,400	121,160
7-6	7-0	15-0	7-0	7-0½	12-6	30-8	19-9	17-3	17-0	14-10	17-0	13-7½
30-11½	27-3	26-4	26-10	23-6½	30-9	30-8	35-11	26-5	25-11	26-1	25-3	13-7½
56-0	57-10¾	53-7½	57-2	59-5	....	64-7	66-0	57-10	60-7	54-6	51-4½	45-7¾
83	79	72	72	68 3-16	61⅝	56	57	57	63	62	62	51
21	21	21	20	14 3-16 & 23⅝	20	20 & 32	19&32x32	23	23	22 & 35	21	21
26	26	26	26	25 3-16	24	32	32	30	32	30	28	28
177	177.1	179.68	166.85	181.1	156.3	219	210	203	189.77	180	167	132.13
....	....	78.54	24.41	....	....	....	....	29	30.23	....	....	....
2,499	2,923.3	2,405.5	3,750.2	2,435.7	1,825.5	5,366	4,586	3,725	3,717	2,312.6	2,224	2,572.97
2,676	3,100.4	2,663.72	2,941.46	2,616.8	1,981.8	5,585	4,796	3,957	3,937	2,492.6	2,391	3,705.10
102	96⅛	119⅞	102	120	94	108	108	108	105 1-16	102⅛	113	80
63	75¼	102	65⅜	54	105	96	78	73¼	75¼	70¼	96	70
43.7	50.2	84.85	46.27	33.9	68.5	72	58.5	55	54.89	49.82	75	38.8
64¼	70⅝	66¼	67-0	59½	66	84	78¾	80	81⅝	70½	68	67
9-4	....	9-5	....	9-9½	9-0 front 9-2.4 back	10-0	....	9-11	9-6	9-3½	9-11	9-4½
294-2	351-2	308-2	330-2	....	447-1¾	436-2¼	391-2¼	460-2	458-2	248-2 & 22-5	298	351-2
16-4	16	15	16-0	14-5¼	9-0	21	20-0	15-6⅛	15-6	14-8	13-2 3-16	14-0
215	200	200	200	227	200	235	225	200	200	200	200	200
Wagon top	Straight	Culm burner	Straight	Straight	Wagon top	Straight	Wagon top	Wagon top	Straight	Wagon top	Straight	Wagon top
Bitum.	Bitum.	Anth.	Bitum.	Bitum.	Anth.	Bitum.	Bitum.	Bitum.	Bitum.	Bitum.	Anth.	Bitum.
Dec. 1903 P. 437	Apr., 1904 P. 153	Aug., 1903 P. 285	Nov., 19 P. 421	June, 1904 P. 203	Oct., 1903 P. 364	June, 1904 P. 237	Oct., 1903 P. 372 Nov., 1903 P. 398 May, 1904 P. 176	Nov., 1903 P. 416 Dec., 190: P. 439 Jan., 1904 P. 12	Jan., 1904 P. 16	Sep., 1903 P. 317	June, 1903 P. 348	May, 1904 P. 184

Note.—This table supplements that presented in this journal as an inset in June, 1903.

In Fig. 2 is illustrated an interesting drive upon a special Niles portable floor-plate drilling machine which is in use at the works of the Bullock Electric Manufacturing Company. The motor, which is a vertical Bullock direct-current motor, is mounted directly upon the top of the column and is geared

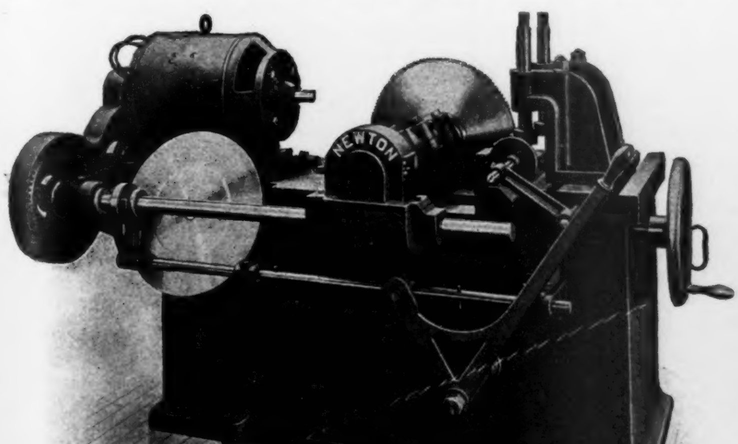


FIG. 3.—DIRECT GEARED MOTOR DRIVE UPON A COLD-SAW CUTTING-OFF MACHINE.—NEWTON MACHINE TOOL COMPANY.

to the vertical-splined driving shaft of the machine without the use of bevel gearing—this is alone a great advantage, but the compactness and simplicity afforded by this arrangement is the most important feature.

Figs. 3 and 4 illustrate additional examples of motor applications to special metal working machinery, the advantages of which will be seen at a glance. The former, a Newton No. 2 cold saw cutting-off machine, is conveniently driven by a Bullock motor which replaces the former belt drive. The latter, a Ferracute punch press for metal stamping work, well shows the advantage of electrical driving for this class of tools; the drive is, in this case, the smallest part of the tool. The motor

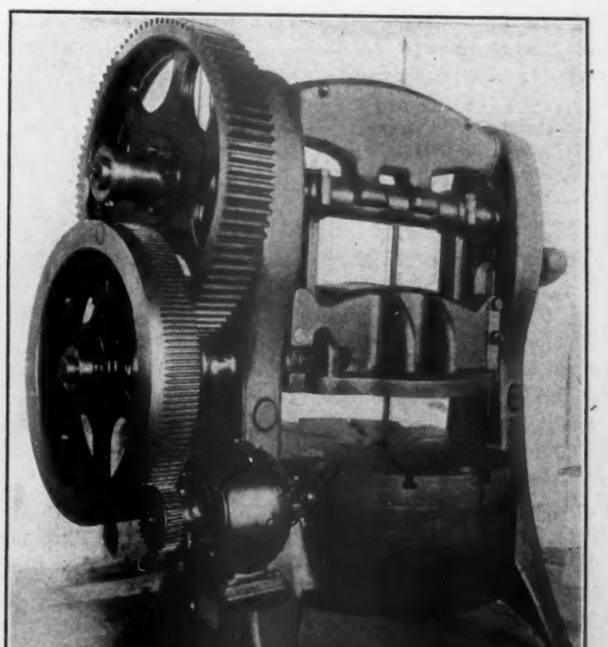


FIG. 4.—CONSTANT SPEED DRIVE FOR A HEAVY FERRACUTE PUNCH PRESS.—NORTHERN ELECTRIC MFG. CO. MOTOR.

used upon the punch is the spherical-type steel-frame motor, built by the Northern Electric Manufacturing Company, Madison, Wis., and operates at constant speed.

The drive upon the grindstone, Fig. 5, a Brown & Sharpe special trough mounted, is very conveniently arranged. The motor, a Bullock direct-current machine, is located at the rear and drives through a combination of gearing and silent chain. The starting box is conveniently mounted at the side of the tub and is protected from splashing by a hood. This drive is of special interest as showing the extent to which individual

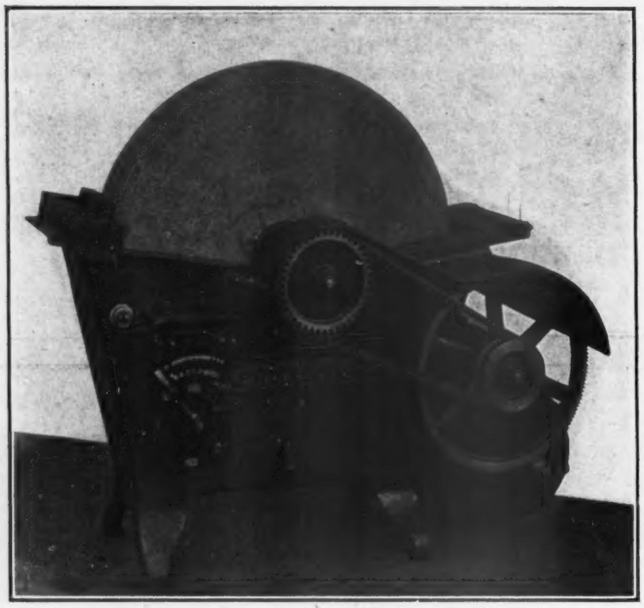


FIG. 5.—AN INTERESTING APPLICATION OF MOTOR-DRIVING TO A GRINDSTONE.—BULLOCK MOTOR WITH SILENT-CHAIN DRIVE.

driving is coming to be used in the operation of small tools, the advisability of this being a much discussed point at present.

HARD SERVICE FOR WHEELS.—In order to keep the wheels of the cars of the Boston Elevated Railroad in good condition it is necessary to grind them every two weeks. The crooked road wears the wheels into polygonal form in a short time and heroic measures are necessary to keep them in condition to prevent noise in operation.

The Rand Drill Company is sending out a mailing card which is a decided novelty. It is in the shape of the new "Imperial" hammer, the address being written on the barrel and a 1-cent stamp fitting into the handle.

HIGH SPEED STEAM LOCOMOTIVE TRIALS IN GERMANY.

Because of the speed of 117.32 miles per hour, attained by an electric locomotive on the experimental track between Marienfeld and Zossen, near Berlin, the results of the speed trials of steam locomotives on this track have been awaited with interest. The steam locomotive tests began last February and have just been completed. Consul Frank H. Mason reports the results, and they are not superior to the speeds of ordinary service on the Camden and Atlantic City line of the Philadelphia & Reading. As a test of electric vs. steam locomotives the trial shows nothing, because the electric locomotives operated singly and the steam locomotives hauled trains of six and three 30-ton cars. Four locomotives were compared.

The first locomotive was built by the Egestorf Machinery Company, of Hanover. It is a 4-4-2 type, and with six cars attained an average speed of 68.97 miles per hour. With three cars the speed was 79.41 miles.

The second locomotive was built at Grafenstadt, a compound, also of the 4-4-2 type. With six cars this engine made 73.32 miles per hour, and with three cars, 76.42 miles.

The third was a 4-4-0 locomotive, built by Borsig, and is similar to the standard passenger engine of the Prussian State Railways. It has a Schmidt superheater, and was designed by Herr Garbe. This engine, with only 963 sq. ft. of heating surface, gave higher speed than the first two, which were specially designed and built for the trials. Its speed with six cars was 79.53 miles per hour, and with three cars 84.5 miles per hour. The horse-power developed approximated 2,000.

The fourth locomotive, which headed the list for speed, is the design of Mr. Wittfield, of the Prussian State Railways, and the cab in front, and is to be exhibited at St. Louis. Both enwas built by Henschell & Sons, of Cassel. It is arranged with gine and tender are encased in a sheathing of steel, giving a smooth exterior surface to reduce the wind friction. This is a 4 4-4 type 4-cylinder balanced compaund. It has 2,766 sq. ft. of heating surface and weighs 76.8 tons. This engine gave a speed of 79.53 miles per hour with six cars, and 85.12 miles with three cars.

OIL FUEL TESTS—NAVY DEPARTMENT.

The Oil Fuel Board of the Navy Department has made public its conclusions from its recent experiments. Some of the most important of them are:

"No difficulty should be experienced by an intelligent fireroom force in burning oil in a uniform manner.

"While the use of steam as a spraying medium will undoubtedly prove most satisfactory for general purposes, the result of the tests show that the consumption of fuel oil cannot be forced to as great an extent with steam as the atomizing agent as when highly heated compressed air is used for this purpose.

"In every oil fuel installation special provision should be made for the removal of the water that will collect from various sources at the bottom of the supply tanks.

"The evaporative efficiency of crude and refined oil is practically the same, no matter from what locality the oil may come. The danger of using crude oil is much greater.

"In order to provide a uniform supply of oil to the burners the oil should be heated by some simple means.

"Where oil is used as a fuel in a Scotch boiler the introduction of retarders in the tubes will undoubtedly increase the evaporative efficiency of the boilers.

"Where crude petroleum has undergone a slight refining or distillation, no ill effects result to modern steel boilers. From the standpoint of endurance of the boiler, the advantage, if any, is with oil. Crude oil, however, by reason of its searching and corrosive effects, has a greater tendency than refined oil to attack the seams and tubes of modern boilers. For marine work, therefore, no crude petroleum should be used, and particularly for ships making long voyages the fuel oil should undergo some mild distillation before being placed in the tanks.

"Under forced draft conditions and with water tube boilers, and with the use of oil as fuel, the solution of the smoke question is nearly as remote as ever. Where a limited quantity of oil is burnt in a Scotch boiler, however, and retarders are used in the tubes, crude petroleum should be smokeless."

The Chicago Pneumatic Tool Company report an excellent condition of their business. President Duntley has forwarded orders from England for 275 machines, fifty of these being rock drills for South Africa. Twenty-five compressors have been ordered for use in Europe, and nine large "D. S. C." compressors have been ordered by the Pennsylvania Railroad. The factories at Franklin, Cleveland and Detroit are running at their full capacities.

STEAM TURBINE TEST.—A pamphlet containing the results of an elaborate test of a direct converted Westinghouse-Parsons turbine, made by Messrs. Dean & Main, has been received from the Westinghouse Machine Company, Pittsburgh. The record is admirably complete, and shows the effect of superheating. Presumably copies may be had by addressing the Westinghouse Company's Publishing Department, Pittsburgh, Pa.

The Canadian Rand Drill Company, Sherbrooke, Quebec, have just closed with the Canadian Westinghouse Company, of Hamilton, Ont., for installation of a Rand-Corliss compound, power-driven, air compressor, to be installed in their new plant. This machine is designed to furnish air for the various pneumatic appliances throughout the works, and is to be driven by a Westinghouse motor, through a Morse chain drive. The International Coal and Coke Company, Coleman, Alberta, have just placed an order with the Canadian Rand Drill Company, Sherbrooke, Quebec, for a 300 h.p. steam driven Rand duplex compressor of the very latest type.

THE GISHOLT BORING MILL.

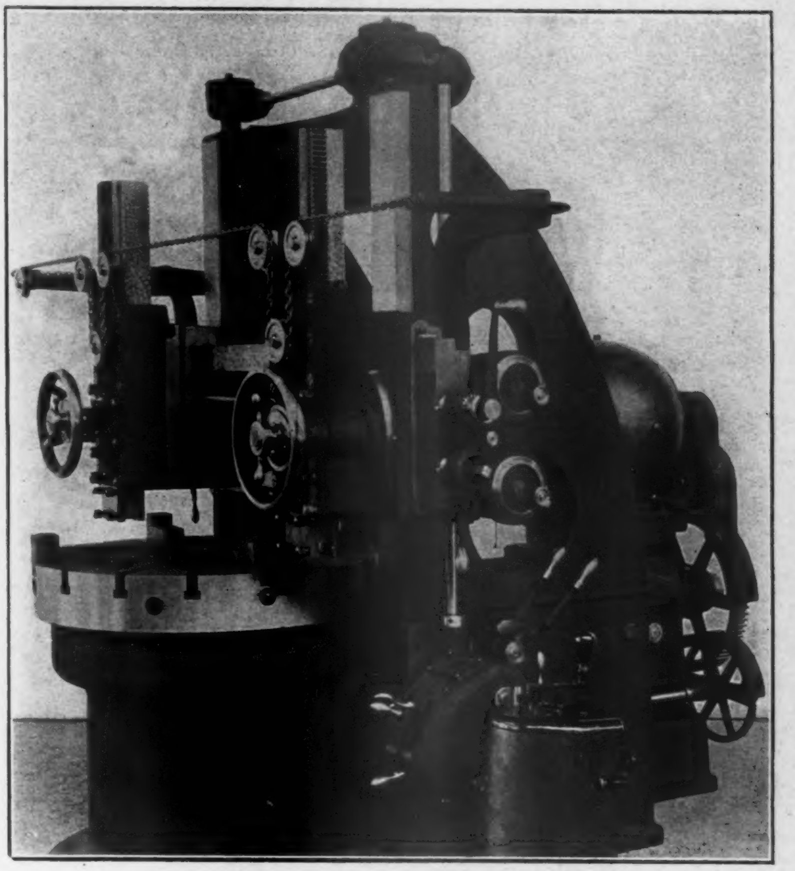
The accompanying engravings illustrate the vertical boring mills manufactured by the Gisholt Machine Company, Madison, Wisconsin. The design embraces several novel and very useful ideas in machine tool construction.

The drive of the machine is of the single pulley, constant-belt speed variety, which has heretofore been used principally in small machines where a variable speed in the spindle was required. The application of this class of drive to machines of this particular character is a decidedly unique idea. While this principle has been used in small machines, as stated, it has been demonstrated a most successful drive in the way it has been adapted to the Gisholt mill. The position of the drive at the rear of the machine brings it entirely out of the way and yet the handiness of the operating levers gives absolute control without necessitating a change of position on the part of the operator. The absence of the old familiar cone pulley is one of the conspicuous features of this mill.

The headstock of this machine is of the friction class, self-oiling, which has been used with such great success by this company on its well-known turret lathes. This form of headstock gives complete control of the table, enabling the operator to instantly stop or start the table, or to move it but a fractional part of a complete revolution without the necessity of starting and stopping the motor or changing in any way the belt connection. It is becoming more evident every day in direct-connected machine tools that the combination is far from satisfactory unless there be introduced somewhere between the motor and the driving mechanism a friction device of some kind. Otherwise it becomes necessary when the tool is stopped to stop the motor, a time-consuming operation of no small importance.

The headstock of the Gisholt mill is so designed that a variable-speed motor with an increase of 50 per cent. above normal will give an almost ideal arrangement of speeds. Thus a very moderate-priced motor equipment only is required in conjunction with this mill. Six mechanical changes of speed are given by this form of headstock, all of which are immediately obtainable by the use of conveniently-located levers. The levers are, of course, non-interfering. The illustrations show how conveniently all operating levers are placed. The operator has every lever within easy reach of his customary position, and the starting and stopping device is controllable from either side of the machine. The changes of speed being all obtained by gearing either through the friction clutch or direct, and the elimination of the cone and belt-style drive, with its attendant shifting and slipping of belts, makes this device far superior in every way. Such an arrangement makes the handling of the machine very satisfactory to the operator, as it requires only the shifting of a lever to get the desired change of speed. Twelve speeds of the table are obtainable.

The heads are entirely independent of each other and may be set to any angle. They are



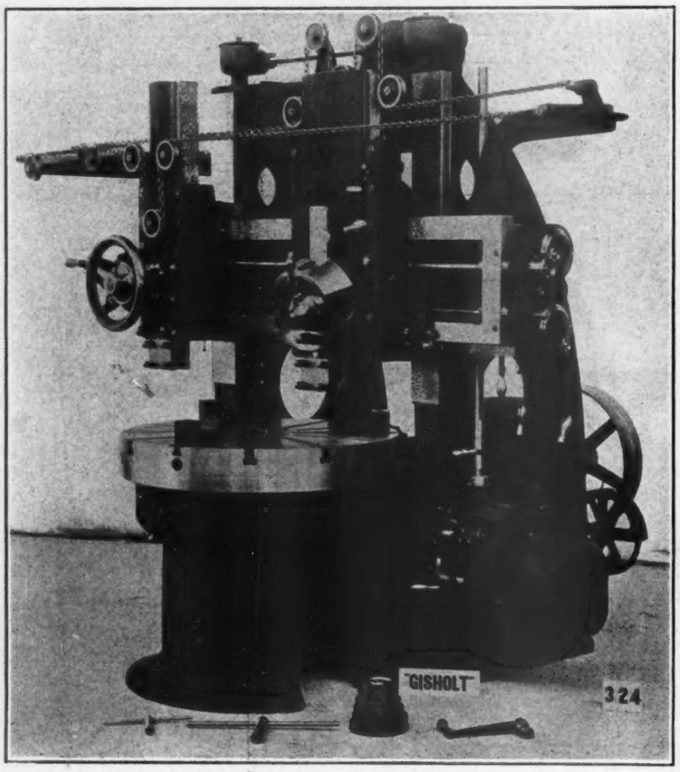
GISHOLT BORING MILL. SIDE VIEW, SHOWING FEEDING MECHANISM AND CONTROLLING HANDLES FOR THE DRIVE.

REAR VIEW OF GISHOLT BORING MILL, SHOWING ARRANGEMENT OF MOTOR DRIVING AND BULLOCK MOTOR.

NEW BORING MILL, GISHOLT MACHINE COMPANY.
EMBODYING A NUMBER OF EXCELLENT FEATURES.

controlled by feed mechanisms located on either side of the machine. The feeds, both vertical and horizontal, are also independent and may be operated by power or by hand. A range of ten feeds is given. Each head is fitted with a positive stop so that the centre of the downslide may be brought to coincide with the centre of the table.

The machines are so arranged that the right-hand head may, when desired, be removed and replaced by a turret head, which



THE NEW GISHOLT BORING MILL, SHOWING COMBINED USE OF PLAIN AND TURRET HEADS.

in addition to its vertical movement may be swiveled to any angle. It is provided with an automatic tripping device. A screw-cutting attachment may be also employed when desired. The feed-tripping device with which this machine is fitted is automatic in its action. By an index dial the operator is able to set the feeds for throwing out at any point desired, either vertical or horizontal, and with very little or no calculation on his part. The mere setting of the tripping device stops the tool accurately at any predetermined point. These dials are plainly shown at the end of the cross-rail. Micrometer index dials, with which both feed-rods and feed-screws are fitted, read to 0.001 inch. Such an arrangement is most convenient, to say nothing of its time-saving qualities. Much calipering is done away with and this arrangement certainly reduces it to a minimum.

All gears on the machine are accurately cut and are incased, and in its general outlines the machine presents a massive yet exceedingly neat appearance. The metal is well distributed and is calculated to withstand the strains attending the work of heavy cutting at high speed. Being practically self-contained no special foundation is required.

The cross rail is of a very rigid construction and, of course, is raised and lowered by power. The table may be a universal combination chuck fitted with three movable top jaws, or a faceplate with independent jaws may be substituted when desired. The table is powerfully geared, being driven by a spur pinion. The spindle revolves on a large self-oiling babbitted surface.

At present these machines are being made in six sizes: 34-in., 42-in., 54-in., 60-in., 64-in. and 74-in. The company will show the mills at the St. Louis Fair, the exhibit being located in Machinery Hall, Block 14, Aisles F and 3.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

XIV.

The importance of the use of the change-gear variable-speed driving mechanism for the drives of drilling machines is rapidly becoming known to users of machine tools and is being regularly specified by them upon orders of new radial drills for general classes of work. The facility with which drilling speeds can be adjusted to the particular class of work in hand is remarkable and affords a very convincing proof of the value to be derived from the use of this improvement. The actual economies that have been effected in many cases from the use of this improvement have been more than sufficient to warrant its application, even upon old drills.

The Dreses Machine Tool Company, Cincinnati, Ohio, have recently perfected a new gear mechanism of this type for use upon the drive of their well known radial drill, which embodies a very interesting principle. This we are permitted to describe in this article, in which is shown a general view, Fig 59, of the 60 in. Dreses radial drill thus equipped and driven by an electric motor, and also details of the main variable speed driving mechanism, Fig. 60, and of the change gear arrangement upon the arm, Fig. 61, by which additional speeds are made available. It is also to be noted that this company has, for some time, been equipping their drills with variable-speed feeding-mechanisms, which operate upon the change-gear principle.

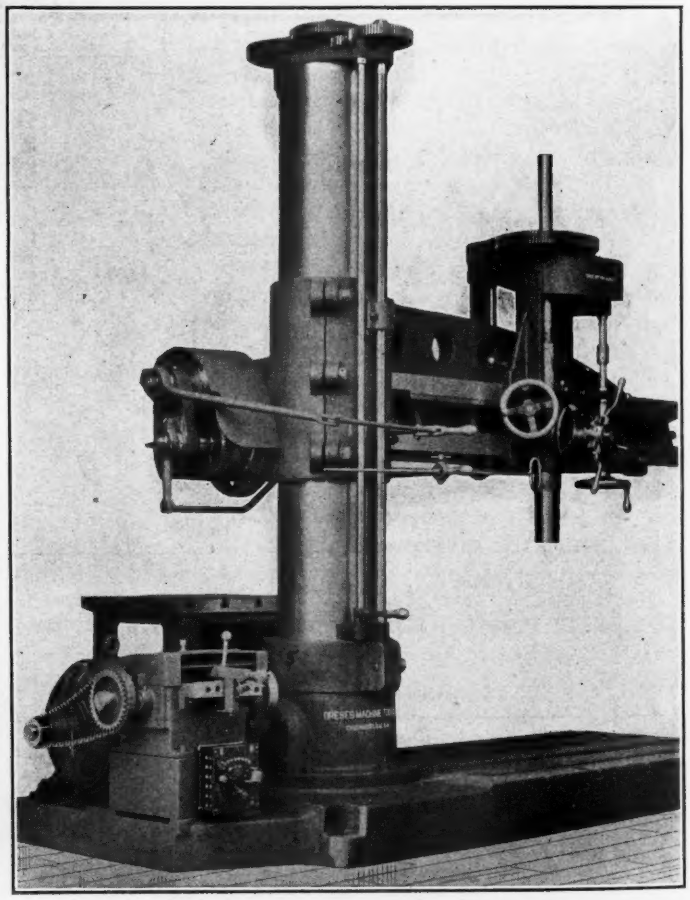


FIG. 59.—THE NEW DESIGN OF DRESES RADIAL DRILL, SHOWING APPLICATION OF GEARED VARIABLE-SPEED MECHANISMS.

The main variable-speed driving mechanism is, as shown in Fig. 59, located at the rear of the drill column upon an extension of the base, in place of the usual driving cone pulley. As ordinarily applied, this carries the main driving pulley of the tool, but as the tool here shown is equipped for direct driving by an electric motor, the belt driving pulley is replaced by a silent chain sprocket. This variable-speed mechanism is operated upon a modification of the cone gear and shifting

pinion principle, by which, in this case, seven different speeds are made available; but, as shown in Fig. 60, the two cones of gears do not operate in mesh, and also the arrangement of the shifting pinion upon a rocker frame is a decidedly new departure.

This speed variator has two shafts, 1 and 2, each with seven gears to it, proportioned for seven speeds in geometrical progression. These cones of gears are not in mesh with each other, but all are fixed to their shafts, except the largest driven gear on the variable-speed shaft 2, which is connected to it by a pawl and ratchet arrangement.

A connection between this ratchet gear and the smallest gear on the driving or constant-speed shaft 1, is formed by an idler pinion, 3, causing the driven shaft to run always at the slowest speed. When the speed of the variable-speed shaft, 2, is increased by proper adjustment of pinion, 4, the ratchet fixed on this shaft runs ahead of the pawl in the loose gear, but in this way shaft 2 is always kept in motion.

The lever with handle, 5, shown in front of the speed variator, is mounted and swings at the rear on a rocker frame, 6, and is so arranged that it can be shifted lengthwise or cross-

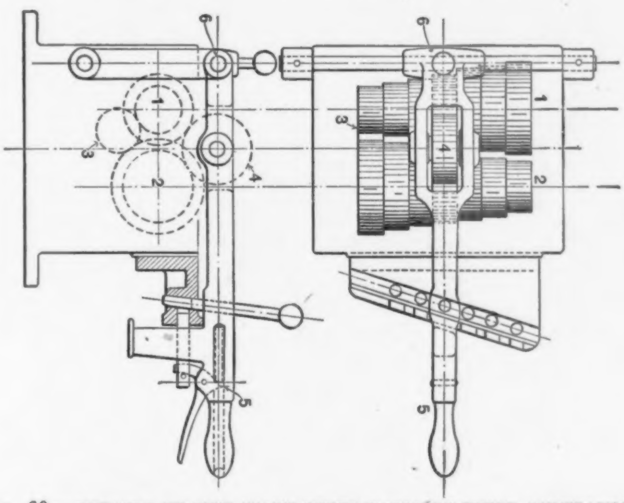


FIG. 60.—DETAILS OF THE MAIN DRIVE VARIABLE-SPEED MECHANISM USED UPON THE NEW DESIGN OF DRESES RADIAL DRILL.

wise. It carries a gear, 4, forming connections between the different gears on the two shafts, 1 and 2, so as to produce the different speeds. The latch with plunger below the handle locks the handle vertically and the knob pin horizontally, all as shown diagrammatically in Fig. 60.

The holes for locking in the index plate are drilled to suit the correct positions of the intermediate gear in mesh with the cone gears. No engagement can be made unless the intermediate gear is in the correct position. Though the entire momentum from rest to the different speeds does not thus require to be overcome, as the variable speed shaft runs always at the lowest speed, the shock from low to high speeds proved to be still too great and a frictional connection between the drill shaft and variator had to be introduced. This friction is similar to a planer feed friction and is adjusted to carry the heaviest load of the drill, but slips when taxed beyond this.

The power is transmitted to the drill spindle in the usual way by a horizontal shaft near the base, a pair of mitre gears and central shaft in column, two spur gears on top of column and outside vertical shaft, V, carrying a sliding mitre gear. This mitre gear engages with the mitre gear on short shaft, A, having fixed on it the pinion B, and the two loose friction gears C and D. Pinion B is arranged to mesh with friction gear E, and C with friction gear F, both on shaft H. Friction gear D drives gear F indirectly by means of an intermediate pinion, G, journaled in the gear casing.

The double friction clutch arrangements in gears E and F are operated by the lever combination J, which, when engaged with one or the other, changes the speed according to the proportion of the gears, this being in geometrical progression with the range of the cone pulleys. The double friction between gears C and D is operated by the lever combination K; when engaged with C, the spindle runs fast right handed, but when engaged with D, on account of the intermediate gear G, it is faster in reverse, in accordance with the different diameters of the two gears C and D.

It is obvious that by clutching D to shaft A, a slow forward speed and fast reverse is obtained by engaging the friction between C and F alternatively. By clutching F to H and operating the friction between C and D a fast forward and a slightly increased reverse speed of the spindle is brought about.

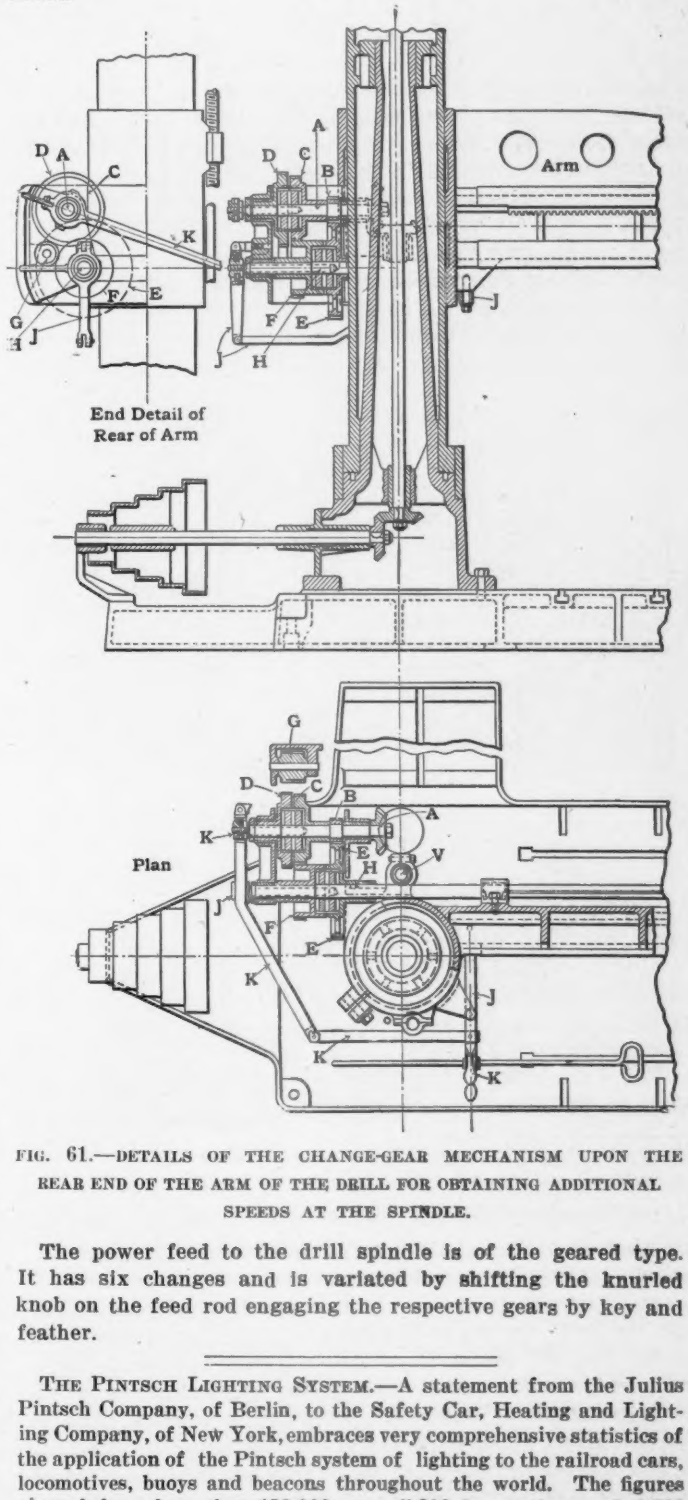


FIG. 61.—DETAILS OF THE CHANGE-GEAR MECHANISM UPON THE REAR END OF THE ARM OF THE DRILL FOR OBTAINING ADDITIONAL SPEEDS AT THE SPINDLE.

The power feed to the drill spindle is of the geared type. It has six changes and is variated by shifting the knurled knob on the feed rod engaging the respective gears by key and feather.

THE PINTSCH LIGHTING SYSTEM.—A statement from the Julius Pintsch Company, of Berlin, to the Safety Car, Heating and Lighting Company, of New York, embraces very comprehensive statistics of the application of the Pintsch system of lighting to the railroad cars, locomotives, buoys and beacons throughout the world. The figures given below show that 130,000 cars, 5,800 locomotives and 1,700 buoys and beacons are equipped with this system, and that 372 gas works are in operation to manufacture gas for the Pintsch system of lighting, which has been adopted by the majority of the railroads and lighthouse departments of the world. In Germany 45,200 locomotives and 5,583 cars are so lighted. The United States stands second, with 23,500 cars, and England third, with 21,100 cars.

Gould Coupler Company.—The offices of this company have been moved from 25 West 33d street to 1 West 34th street, New York City.

A NEW DESIGN OF CUTTER AND REAMER GRINDER.

THE BECKER-BRAINARD MILLING MACHINE COMPANY.

An interesting new design of cutter and reamer grinder has recently been perfected and placed upon the market by the Becker-Brainard Milling Machine Company, Hyde Park, Mass., which will be received by those interested in machine shop operation with more than usual interest. It embodies many new ideas and has a much greater range than most tools of this type. It is unlike other cutter grinders in that it requires no extra fixtures for handling any style of milling cutter or reamer. It has two separate knees, each provided with its own slides. The cutter to be ground is transferred from one to the other for the different operations on the side and teeth. The following cuts will explain the operations on the several different styles of cutters shown:

Fig. 1 gives a view of the machine as regularly made, from which we get a very good idea of the weight and proportion as a whole. Here also may be seen the two different knees mentioned above. On the left hand side of the machine is the main knee, which swivels around the supporting column and carries the head and tail stock for grinding cutters on centers, or with bar inserted in place of the head stock center and tail stock removed. Cutters are ground by sliding them on the bar in front of the wheel, which insures a cutter ground straight and true with the hole. On the right hand side is a novel arrangement for grinding the end mills, or the side teeth of straddle mills and inserted tooth cutters. This sliding head can be swivelled for grinding bevel or dovetail mills, and is provided with a plunger finger, which is always set on the center. The object in this arrangement is to do away with many of the devices ordinarily used for this work, and it is also unnecessary to use any other than a 7-inch emery wheel, as shown.

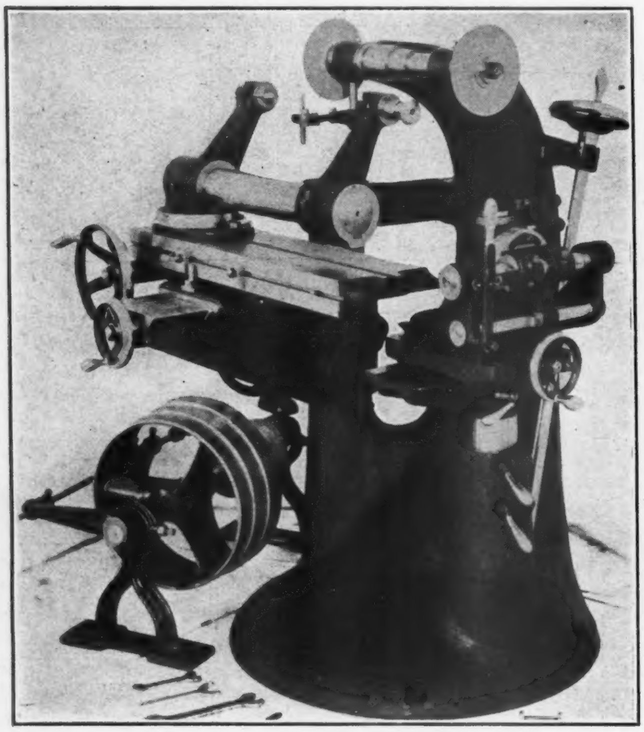


FIG. 1.—BECKER-BRAINARD CUTTER AND REAMER GRINDER.

In Fig. 2 the machine appears as arranged with motor driving. This is a view of the model which is on exhibit at the Becker-Brainard Milling Machine Company's space No. 13, Machinery Hall, Louisiana Purchase Exposition, St. Louis, Mo.

Figs. 4 and 5 show good illustrations of the improved manner of handling work on the machine, showing as they do straddle and end mills in both positions. This also shows how the clearance is obtained on the end and side teeth.

Fig. 3 presents a front view of the sliding head set for grinding bevel cutters. In Fig. 6 is shown a large inserted tooth-face mill in the sliding head that is probably the most difficult cutter to handle on any grinder without using special fixtures. The sliding head arrangement on this machine makes this a very simple operation.

This machine has a capacity for all styles of cutters up to 14 ins. diameter and 14 ins. long. It is designed distinctively as a cutter and reamer grinder to fill the long felt want for a machine capable of grinding heavy cutters of large diameter and long face, which are used on the large column and planer type milling machines, also the large diameter inserted tooth cutters. The machine will take care of all styles and sizes of cutters, including plain, straddle, form and end mills, being made especially stiff and heavy to eliminate vibration which frequently occurs in most of the lighter grinders.

The machine is provided with two columns, one of which has a knee, with saddle and table, which has 6 ins. of vertical adjustment, and will swivel around the column in either direction. The adjustable vertical column is graduated so that seting can be instantly made to give the proper angle of clearance of cutter for different diameters of emery wheels used.

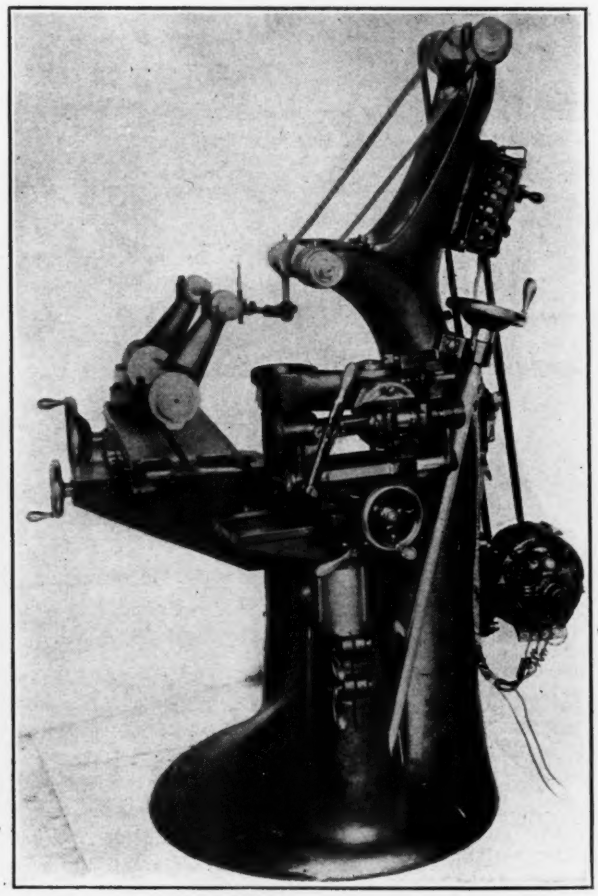


FIG. 2.—SHOWING THE MACHINE ARRANGED FOR MOTOR DRIVING.

The table on the saddle is fed by rack and pinion, having a longitudinal feed of 20 ins. and cross feed of 7 ins., and is provided with graduated swivel head, which carries a bar on which to slide cutters while being ground. Head and tail centers are also provided for holding end mills and reamers which have to be ground on centers.

With the other cutter grinders on the market it is necessary, in order to grind side, face and angular mills, to use special fixtures, which consume more or less time in setting, whereas with this machine this is unnecessary, as a second column is provided with swivel carriage carrying two cross slides, the top cross slide having 7 ins. and the lower cross slide 9 ins. adjustment at right angles. On the top slide is mounted a graduated swivel head, or holder, which slides on a bar having a travel of 5 ins.. used for grinding the end teeth of cutters and end mills.

Thus cutters of all description can be ground without any change of fixtures, and much faster than the old methods of cutter grinding.

SPECIFICATIONS.

Centers swing 14 ins. and will take between same	14 ins.
Maximum length that can be ground between centers	14 ins.
Longitudinal feed of table	20 ins.
Cross feed	8 ins.
Elevation of knee on column	6 ins.
Side knee elevation	10 ins.
Lower cross slide	9 ins.
Top cross slide	7 ins.
Cutter head slides on bar	5 ins.
Weight	1,570 lbs.

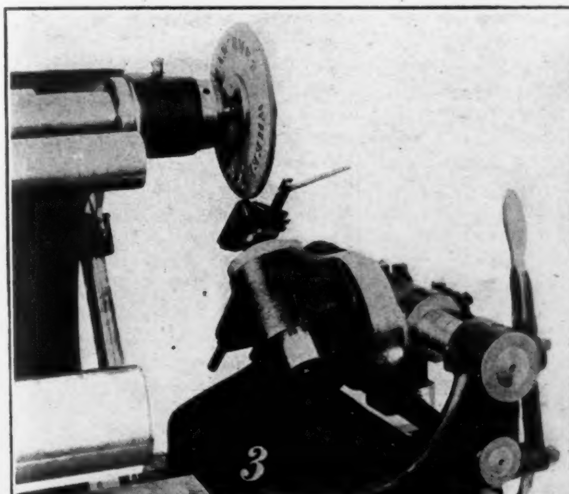
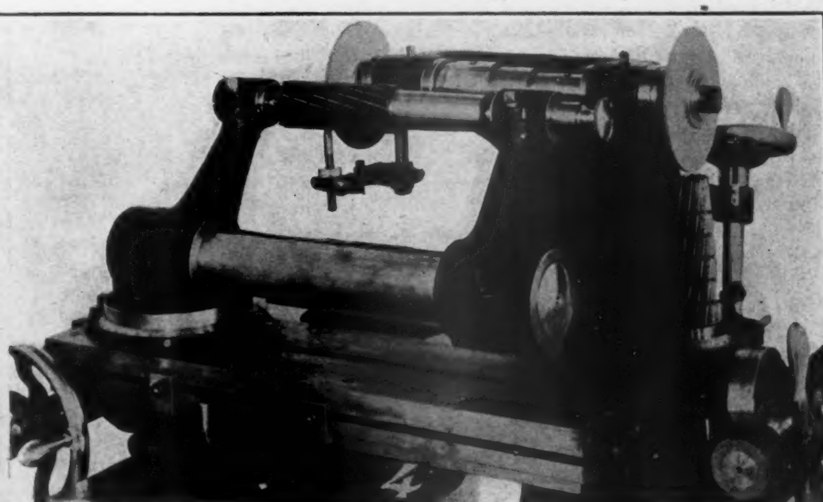
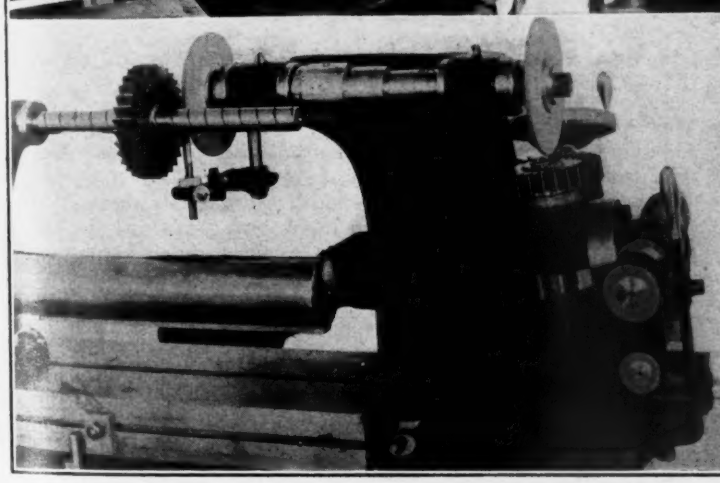
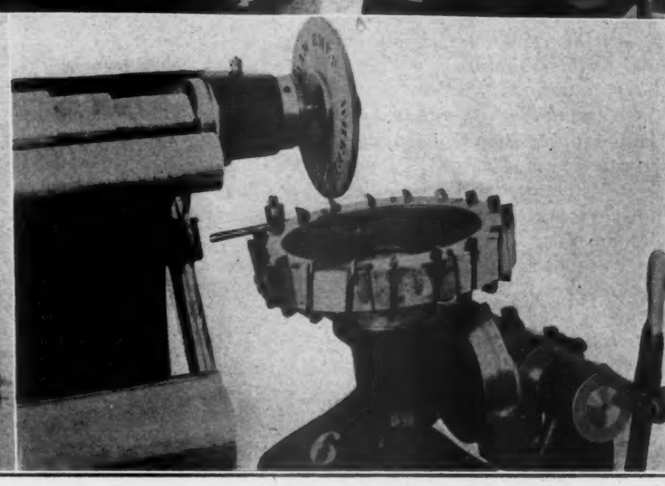





FIG. 3.—FRONT VIEW OF SLIDING HEAD GRINDING BEVEL CUTTER.

FIG. 4.—GRINDING SIDE AND END OF TAPER SHANK OF END AND SIDE MILL.

FIG. 5.—GRINDING FACE AND SIDE OF STRADDLE MILLS.

FIG. 6.—SLIDING HEAD, GRINDING LARGE INSERTED TOOTH FACE MILL.

NEW DESIGNS OF CUTTER AND REAMER GRINDER—BECKER-BRAINARD MILLING MACHINE COMPANY.

TESTING PLANT ON THE GREAT WESTERN RAILWAY, ENGLAND.*

BY G. J. CHURCHWARD.

The Great Western Railway Company have recently put down in their erecting shop at Swindon a plant for testing locomotives. This machine consists of a bed made of cast-iron, bolted on a concrete foundation, with timber baulks interposed for the lessening of vibration. On this bed five pairs of bearings are arranged to slide longitudinally so that they may be adjusted for any centres of wheels that are to be put upon the plant. In these bearings axles are carried having wheels fitted with steel tires, on which the locomotive runs. These axles are also fitted with drums on which band-brakes act for absorbing wholly or in part the power developed by the engine. Outside these band-brakes, pulleys having an 18-in. face are provided at each end of the axle for driving link belts, by which it is intended to transmit the major portion of the power developed by the engine to air-compressors, so that it may not be wasted.

The hydraulic brakes will then only absorb just enough power to enable them to govern the speed of the engine. These brakes are actuated by a water-supply from an independent pump, the outlet of this water-supply being throttled either by a stop-valve or by a throttle actuated by a centrifugal governor. This latter device enables the speed of the engine to be set at any required number of revolutions and kept constant.

The carrying wheels are 4 ft. 1½ ins. diameter. The main bearings are 14 ins. long by 9 ins. diameter. The tire of the carrying wheels is turned to approximately the same section on the tread as the rails in use on our line. This plant is intended not only for the purpose of scientific experiment, but also to do away with the trial trips of new and repaired engines on the main line. It has, therefore, been necessary to make it rapidly adjustable to take engines having wheels of different centres. The main bed is provided with a rack, and each pair of bearings is provided with a cross shaft having a pinion at either end. These cross shafts are driven from a longitudinal shaft through suitable clutches. This longitudinal shaft is operated by electric motor and is capable of being reversed. The engine is run over the machine on an elevated frame which carries it on the flanges of its tires clear, electrically, and drops the engine into position on the carrying wheels with their bearings till they are vertically underneath the wheels of the engines to be tested. The frame is then lowered electrically and drops the engine into position on the carrying wheels.

When running engines on trial trips it is essential that the bogie and trailing wheels of engines so fitted should be run as well as the driving wheels, in order that the axle-boxes may take a good bearing, and be seen to be in satisfactory condition before handing the engine over for traffic. To accomplish this the carrying wheels are all coupled together by a suitable arrangement of belts and jockey pulleys. It, therefore, follows that even when a locomotive having a single pair of driving wheels is run on the plant, all the carrying wheels are rotating and in turn run the bogie and trailing wheels of the locomotive. The jockey pulleys are necessary to retain the proper tension on the belts when the bearings are moved longitudinally.

Owing to the varying height of the footplates of different classes

*From a paper read before the American Society of Mechanical Engineers, June, 1904.

of engine, it has been found necessary to provide a firing stage which can be rapidly adjusted vertically. A large coal bunk is provided in connection with this stage and also weighing machines. Two water tanks are mounted on the same platform, for measuring the water used when running, these tanks being emptied alternately when the consumption test is being made.

Under the platform a dynamometer enables the drawbar pull of the engine to be taken, and this, together with counters on the wheels, will enable the actual drawbar horse-power to be measured, and so compared with coal and water consumption for various classes of engines. As engines of different lengths are to be tested, and of necessity have to be fixed at the trailing end to the dynamometer, it is necessary to have a sliding chimney for carrying off the steam and smoke from the engine when running. This has been provided in the form of a long box, having a steel plate running on rollers forming its lower surface, which plate carries a large bell-mouthed chimney. This box not only enables the chimney to slide longitudinally, but will also form a receptacle for ashes and any other matter ejected by the engine, which will be retained and can be examined both for quantity and quality.

It is hoped that this plant will enable many questions of the relative economy of different classes of engines, either simple or compound, to be settled definitely. The question of superheating might be investigated on it, as also the efficiency of various forms of smokebox arrangements. The effect of various percentages of balancing can be investigated, and, in fact, any of the experiments which are at present being made on the road may be made on this plant, with the great advantage that any engine which may be selected can be placed in position ready for testing, and all connections made in a time probably not exceeding an hour.

From a supplementary paper, by Mr. W. F. Pettigrew, the following is taken:

RESULTS REQUIRED IN THE TESTING OF LOCOMOTIVES.

Mean boiler pressure. Throughout journey.
Total coal used. Exclusive and inclusive of lighting up.
Coal burnt per hour. Running time and journey time.
Coal burnt per square foot of grate area per hour of running time and of journey time.
Coal burnt per I.H.P. per hour running time and journey time.
Coal burnt per train-mile, engine-mile, ton-mile, and per pound. Pull on drawbar per mile, also per hour.
Calorific value of 1 lb. of coal in B.T.U.
Ashes in smokebox, in ashpan, in firebox, total percentage.
Total water evaporated.
Water evaporated per hour running time and journey time.
Water evaporated per square foot of total heating surface per hour, both running time and journey time.
Water evaporated per I.H.P. per hour. Running time.
Water evaporated per train-mile and per engine-mile.
Water evaporated per pound of coal, exclusive and inclusive of lighting up.
Water evaporated per hour. From feed temperature and equivalent from and at 212 deg. F.
Maximum I.H.P.
Mean I.H.P. calculated from indicator cards from work done.
Curve of horse-power. (Mean height.)
Maximum speed.
Mean speed. Exclusive and inclusive of stops.
Actual running time and journey time.
Train and engine miles.
Time from lighting up to taking out fire.
Temperature of water in boiler at time of lighting up.
Maximum and mean vacuum at base of chimney.
Maximum and mean vacuum, level with top of blast pipe.
Maximum and mean vacuum at middle of middle row of tubes.
Maximum and mean pressures through fire-hole door.
Maximum and mean pressures through ashpan.
Maximum and mean temperatures of smokebox gases.
Efficiencies of engine, boiler, and engine and boiler combined.
Maximum gradient.
Coal stated includes that used while standing for ——— hours.
Maximum and mean pull on drawbar.
Maximum and mean load hauled in tons, exclusive of engine tender, passengers, and luggage.
Maximum and mean number of vehicles hauled.
Maximum and mean number of journals.
Mean load per journal.
Back pressure at maximum I.H.P. and maximum speed.
Heat (in B.T.U.) carried away by the products of combustion.
Heat expended in evaporating the water.
Heat lost by radiation, imperfect combustion, and evaporative moisture in coal.
Heat converted in work per minute.
Heat taken up by the feed-water per minute.
Relative consumption of coal based on pull of drawbar.
Relative consumption of coal based on pull of I.H.P.
Relative consumption of coal based on pull of ton-mileage.
Relative consumption of coal based on pull of calorimeter tests.
Relative value of coal = Relative consumption multiplied by cost per ton delivered.

The results obtained should all be shown graphically by means of diagrams, which should give the profile of the line run over.

PUBLICATIONS.

The Metric Fallacy and Metric Failure In The Textile Industry, By F. A. Halsey and S. S. Dale, New York. D. Van Nostrand Co., 23 Murray street, 1904. Cloth, 231 pages. Price $1.00.

This book is a vigorous and carefully considered attack upon the metric system and constitutes an effort in the direction of preventing proposed compulsory legislation in favor of the use of the metric system. Those who follow the proceedings of the American Society of Mechanical Engineers know of Mr. Halsey's uncompromising opposition to the metric system and the book under review contains his arguments as presented to that society. The authors show the general undesirability of metric units and they prove beyond a doubt that the supposed universal and exclusive use of metric measures in the so-called metric countries merely amounts to the addition of a new unit to those which have already been in general use, and that instead of simplifying measures the metric system in those countries has added to the confusion or "Continental Chaos," as Mr. Halsey puts it. The book needs to be understood or it appears to be an unnecessary work. Of course the metric system will come into universal use if it is what it is claimed to be, and no books can stop it. But the object of this work is to prevent legislative action by those who do not know the shortcomings of the metric system and the experience of foreign countries in its use. Undoubtedly Mr. Halsey's efforts have been effective in carrying out his object. He certainly has prepared a powerful brief in the case against the metric system.

Transactions of the American Society of Mechanical Engineers. Vol. 24, 1903. The Annual Report of the 46th and 47th Meetings of the Society. 1,563 pages, fully illustrated. Published by the Society, from the Library Building, 12 West Thirty-first street, New York City.

This volume contains the papers and reports presented at the New York meeting of the society for 1902 and at the Saratoga meeting for 1903. The list of papers presented at these meetings embraces a wide range of subjects, many of which are of general interest. The final report of the committee upon the standardization of steam-engine testing appears in this volume; this and the discussion on the preliminary forms of the report of this same committee occupy 136 pages. Another valuable paper upon the subject of "The Bursting of Emery Wheels," by Mr. Benjamin, was presented at the Saratoga meeting, supplementing his former paper of the previous year. The only report presented that bears directly upon railroad operation, however, is a paper entitled "A Rational Train Resistance Formula," by John B. Blood. This volume of the Transactions is one of the largest that has been pubilshed; it contains 1,563 pages and is nearly 3 ins. thick.

A Clean Chimney. The Economical Burning of Coal Without Smoke. By A. Bement. Published for private circulation by Peabody Coal Company. Chicago, 1904.

This little book of 50 pages treats of the subject of correct methods of burning soft coal, particularly washed coal. It was written for the Peabody Coal Company by Mr. Bement, who is a specialist in combustion and is thoroughly qualified to present this subject. It is intended for firemen, engineers, and proprietors of steam plants, and is an excellent brief treatise on the subject of economical and smokeless use of coal.

The Ashton Valve Company, Boston, Mass., announces that J. W. Motherwell has become associated with its railroad department, with headquarters at 160 Lake street, Chicago, Ill. Mr. Motherwell has, for the past eleven years, been connected with Fairbanks, Morse & Co.

The Standard Scale and Supply Company.—This company announces the removal of the word "Limited" from its name, and the limited partnership, with a capital of $75,000, has been succeeded by a corporation with the same title, with an authorized capital of $600,000, of which $450,000 has been issued. This change fol-

lowed the completion of the new factory at Beaver Falls, and the abandoning of the old one at Bellefonte, Pa. The new factory is up to date in all respects, and is electrically equipped. The offices of the company are at 211 Wood street, Pittsburgh, Pa.

GRAPHITE AS A LUBRICANT.—The Joseph Dixon Crucible Company, Jersey City, N. J., have issued the eighth revised edition of this pamphlet, which illustrates the many and varied applications of graphite to the lubrication of machinery. The subject is considered both scientifically and practically.

NATIONAL CAR COUPLER COMPANY.—This company has issued an excellent illustrated catalogue devoted to its complete line of couplers and accessory devices. Among them are the Hinson emergency knuckle, the National centering yoke, National steel platform and buffer and the Hinson draft gear. Each of these is described in the text by aid of engravings showing the devices themselves and working drawings illustrating their application.

CORRINGTON AIR BRAKE COMPANY.—"Bulletin No. 1," just issued by this company, contains an illustrated description of their new air-brake system, and by aid of remarkably fine halftone engravings from wash drawings the leading features of the apparatus are clearly presented. The text describes the system, concerning which an article appeared on page 146 of our April number. The illustrations include two large folding plates showing a complete freight equipment, and another illustrates the passenger equipment, tender and car equipment, shown in connection with the consolidated engineer's valve. This bulletin is a remarkably fine piece of catalogue literature.

AIR AND GAS COMPRESSORS.—The Rand Drill Company, 128 Broadway, New York, has issued a miniature compressor catalogue which illustrates and briefly describes some of its standard types of air and gas compressors. The lists are necessarily condensed in order to present the information in small volume, but they are sufficient for the selection of a compressor of suitable type and size for ordinary requirements. Each compressor is illustrated on a separate page, and in every case a reference is given to the particular catalogue in which a complete description of the machine is presented. This little pamphlet contains a list of branch offices through which complete information may be obtained.

HAVERHILL ECLIPSE DRY DUST FIRE EXTINGUISHER.—Adreon & Co., Security Building, St. Louis, Mo., have issued a 24-page pamphlet illustrating and describing the Eclipse dry dust fire extinguisher. This consists of a long tin receptacle fitted with a loop for hanging against the wall, and it contains a fluffy dust which is said to have remarkably effective qualities for extinguishing incipient fires. The chemical dust is not poisonous, and will not explode, freeze, corrode or deteriorate. The pamphlet contains explanations of the use of the extinguisher, and letters from various concerns, chiefs of fire departments and others as testimonials. The superior claims of this extinguisher over those involving the use of liquids are strongly urged. It is stated that among others using these extinguishers are the United States Government and the Standard Oil Company. Information may be obtained from Mr. D. R. Niederlander, secretary Adreon & Co., Security building, St. Louis, Mo.

WORKS OF WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.—A handsome publication bearing this title has just been received from the Westinghouse Company's publishing department. It illustrates by excellent half-tone engravings exterior and interior views of the various departments of the enormous establishment of this company at East Pittsburgh. It is devoted to a description of the plant, and conveys an impression of its gigantic character and efficient management, combined with efforts in the direction of improving the welfare of the workers. The booklet traces the development from the organization in 1886, with a force of 200 men, to the present time, when 9,000 persons are employed in this wonderful plant at East Pittsburgh. The sociological aspect of the works and their surroundings adds to the interest and importance of this pamphlet, which is unique in literature of this character. One cannot fail to admire the organization and methods which are described.

"South African Rock Drill Tests" is a convincing leaflet just published by the Rand Drill Company. It is a fac-simile reproduction of a page taken from the Johannesburg (South Africa) *Star*, and contains an account of the now famous drill tests carried on by the Engineers' Association of the Witwatersrand. The circular is folded and addressed on the back, and has been mailed to all lines and mine owners. The verbatim report of the engineers is in favor of the drills of American make, and Mr. Docharty supplements his article by the remark that "The 'Slugger' approaches the ideal."

PUMPING MACHINERY.—Messrs. Fairbanks, Morse & Co. have issued a new pumping machinery catalogue, "No. 48 C," which presents complete information with respect to their very large line of pumps of all descriptions and arranged for all of the usual methods of driving. In supplying machinery of this kind this company keeps close watch of the requirements of purchasers and keeps its line of equipment up to the demands by continual improvements. Those who have not already procured this catalogue, and are interested in machinery of this character, should take immediate steps to secure a copy. In addition to illustrated descriptions of the various types of pumps, a great deal of information is presented which will be useful to the purchaser in determining the size of the pump required, and also in ordering repair parts.

TWIST DRILLS AND ACCESSORIES.—The Morse Twist Drill and Machinery Company, of New Bedford, Mass., has issued a new 272-page catalogue of its products. That such an extensive catalogue is required to illustrate its drills, reamers, milling cutters, gauges, dies, taps and other specialties indicates the large variety of the products of this concern. It is impossible to enumerate all of the features of this catalogue, which is the largest and most complete ever issued by this company. It is sufficient to say that it is an excellent book of reference for its line of manufacture. Special attention is directed to the new "Twentieth Century Drill," of which both body and shank are ground on centers after hardening, insuring true running and accurate size. This drill has a large amount of radial clearance, which reduces greatly the friction of the drill in the hole. Among the new tools illustrated are shell drills, indexed cases for sets of drills, counterbores with interchangeable blades and guides, adjustable caliper gauges, standard reference disks, cotter mills, gear cutters, geartwisting machines, and bench center and straightening presses.

THE BALDWIN LOCOMOTIVE WORKS.—An exceedingly attractive pamphlet has been prepared for use in connection with the exhibit of the Baldwin Locomotive Works at the St. Louis Exposition. It opens with a brief history of the works, and describes in an interesting way the first locomotive built by them, and successively the locomotive completing each 1,000 which they have turned out, the descriptions being accompanied by excellent half-tone engravings. This record constitutes a continuous history of the development of the steam locomotive in the United States, leading up to the twenty-third thousandth, which was completed at these works last year, and the twenty-fourth thousandth, which forms part of the present exhibit at St. Louis. Following this portion of the pamphlet is a record of a fast run of the twenty-fourth thousandth locomotive, which is a Vauclain balanced compound, on the Santa Fe. The remainder of the book is taken up with figures and dimensions of a number of typical steam locomotives, and the pamphlet closes with descriptions of electrical locomotives and trucks for elevated railway service. The engravings are remarkably fine and the letter press is of the very highest standard adopted by these works.

ALLIS-CHALMERS COMPANY.—Mr. C. C. Tyler has been appointed general superintendent of all the works of the Allis-Chalmers-Bullock interests in the United States. He has had an exceedingly wide experience in the management of large machine shops, among which are the works of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, of which he was recently superintendent, and before going to Pittsburgh he was widely known as a successful works manager. Mr. Tyler is believed to have no superior in this country in design, construction, equipment and administration of manufactories. In entering upon this new and enlarged field he is sure to carry with him the congratulations of the engineering profession. This appointment is another evidence of the strength with which the Allis-Chalmers organization is being completed.

MASTER MECHANICS' ASSOCIATION.

THIRTY-SEVENTH ANNUAL CONVENTION.

SARATOGA, N. Y., JUNE 27 TO 29.

ABSTRACTS OF REPORTS AND PAPERS.

AUTOMATIC STOKERS.

COMMITTEE—J. F. WALSH, J. G. NEUFFER.

Saving in Fuel.—The only comparative test that your committee has been able to make shows that there is a saving of not less than 7 per cent. when using the stoker, as compared to the work done by a first-class fireman. This, of course, would indicate a considerably greater saving as compared with locomotive firemen as they are ordinarily found. In the case mentioned the engine equipped with the stoker was in service over its run 6 h. and 30 m., while the engine that it was compared with was only 4 h. and 7 m. going over the same length of division. The saving in coal when using the stoker is no doubt very largely due to the fact that when using the stoker the coal is much more evenly distributed, and the furnace door remains closed all the time.

Smoke.—When using the stoker the smoke is very much lighter in color, indicating, of course, a much more thorough consumption of the gases. The darkest color, when the stoker is used, is not more than brown, while most of the time the emission from the stack shows pure steam.

Reducing the Work of the Fireman.—When the stoker is used the fireman has to raise the coal from the level of the coalbin of the tender into the hopper of the stoker, a distance of about 30 ins. This is more than when firing directly into the furnace, but it must be remembered that when the stoker is used the fireman is not required to throw the coal at all. With the coal-conveyor in service the labor of raising the coal into the hopper will be entirely dispensed with, and the work of the fireman becomes simply that of an expert in charge of an efficient machine.

Saving in Repairs to Firebox.—There is no doubt that with the stoker in use very much less trouble with leaky flues will be found, on account of maintaining a more even heat in the firebox. The sheets of the firebox will last longer for the same reason. It has been proven that corrugation in fireboxes is due largely to the changes in the temperature in the fireboxes.

Regular Steam Pressure.—When using the stoker the steam pressure may be kept absolutely constant. This is due to the regularity with which the coal is placed on the grates, the evenness with which it is placed there, and also the fact that the furnace door not being open, the furnace is not cooled by the in-rush of air.

Service in Which the Stoker Will Prove Most Valuable.—It is the opinion of your committee that on the ordinary American type of engine there is no necessity whatever for the stoker, as the fireman, of course, must be there anyway, and the work is not such that an ordinary man cannot execute it with ease, but with the long-firebox type of engine on a long run over a division comparatively free from grades, where the engine is loaded to its maximum capacity all of the time, is where we believe the stoker will be found the most valuable, as a machine will not tire, and consequently will enable the engine to carry the maximum pressure all of the time and get the full benefit of the tractive power of the engine over a long continuous trip. This cannot be done with the hand-firing method on the type of engine above mentioned where the runs exceed 75 miles in length.

Capacity of the Stoker.—The present type of stoker will throw about 3,000 lbs of coal per hour. A modern type of passenger engine, with 46 sq. ft. of grate surface and burning 200 lbs. of coal per square foot of grate per hour, will require about 9,200 lbs. of coal per hour. The stoker, as it is built at present, will not accommodate such a firebox, but we see no reason why the speed cannot be increased and the size of the trough so increased that a larger amount of coal will reach the firebox at each stroke.

BEST PRACTICE IN PAINTING LOCOMOTIVES.

REPORT OF COMMITTEE OF MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.

We desire to submit the following suggestions:

First—As the passenger locomotives run in connection with passenger equipment cars, they should be treated in the manner of finish in all respects equal to the cars.

Second—Freight locomotives should be painted mainly for durability. From this we would not like to be understood as stating that any kind of painting is good enough for the freight locomotive and no attention paid to surfacing, for we consider a certain amount of filling on the rough parts in the line of economy, because it facilitates the cleaning when locomotives are in service.

Third—Castings and woodwork on which a good surface is desired should be made as smooth as possible before the application of paint material.

Fourth—We discourage the painting of locomotives in roundhouses, and would recommend that whenever possible they be run into the paintshop for the finishing coat of varnish.

Fifth—For painting new parts we consider the following good practice: First day, sand-blast and apply the priming coat of paint; second day, drying; third day, second coat; fourth day, putty and fill rough places with knifing surfacer; fifth day, first coat of rough stuff; sixth day, second coat of rough stuff; seventh day, guide coat and rub; eighth day, two coats of color; ninth day, stripe and letter; tenth day, varnish with finishing varnish; eleventh day, drying; twelfth day, varnish with finishing varnish. When absolutely necessary the above practice can be shortened two days by applying two coats of rough stuff in one day and applying the second coat of varnish on the following day by eliminating the day allowed for drying.

Sixth—For repainting locomotives undergoing repairs we submit the following schedule, which can be varied as conditions and circumstances may require: First day, prepare and apply priming coat where necessary; second day, putty and knifing surfacer; third day, color; fourth day, stripe and letter; fifth day, finishing varnish; sixth day, finishing varnish.

On account of the difference in the condition of the paint and varnish on locomotives when they are returned to the shops for repairs, we believe that much should be left to the judgment of the foreman painter as to what operations can be added or omitted in order to expedite the work without detriment to its durability and appearance. These schedules are based on the time required for cab and tank, it being understood that the other parts are being coated by the same method as rapidly as the machinists' work will permit.

Seventh—We would like to emphasize the importance of having locomotives properly cleaned while they are in service, not only to make them more pleasing to the eye, but in order to obtain the best results from the paint material which has been applied.

Eighth—In the way of labor-saving appliances and facilities we would recommend the sand blast, the material-saving paint sprayer, the potash vat, the stationary scaffold, suitable mixing benches, paint stockroom (where conditions warrant it).

TON-MILE STATISTICS—CREDIT FOR SWITCH ENGINES.

COMMITTEE—C. H. QUEREAU, G. R. HENDERSON, G. L. FOWLER.

This committee recommended the substitution of the "ton-hour" for the usual "6 miles per hour" basis for credit for the work of switching locomotives, the ton-hour being advocated as a fairer unit for comparing engines of varying weights and capacities. The ton-hour is obtained by multiplying the total weight of the engine (excluding tender) in tons by the number of hours in service.—EDITOR.

"TECHNICAL SCHOOL GRADUATES: WHAT CAN BE DONE TO RETAIN THEM IN THE RAILROAD SERVICE AFTER THE COMPLETION OF THEIR SPECIAL APPRENTICESHIP?"

BY MR. R. D. SMITH.

A great many roads have inaugurated a system of special apprenticeship. It is doubtful whether these systems are identical on any two roads. The time of service varies as does also the nature of the work required. The object desired is the same in all cases, however. It is to so blend the man's theoretical and practical knowledge that by the time he has finished his special apprenticeship the combination produced may be of more value to the railroad than either of these attributes taken separately.

It has been a noticeable fact that a great many special apprentices never complete their service as such, or, if they do complete it, they do not remain with the railroad very long after having done so.

The causes of this condition are various. It is very often the case that a special apprentice finds the work is not to his liking. There is nothing very unusual about this. A technical graduate is usually twenty-two or twenty-three years old and at this age may not have definitely decided upon the line of work he intends to follow. Upon trying railroad work he may not find it to his liking and gives it up. This is as it should be, and is best for all concerned. There should be no effort made to hold men at work which they do not like.

The wages received during their special apprenticeship are in some cases immeasurably low. Some railroads start these men at the rate of 10 cents an hour. Such a rate is not very much of an inducement when we compare it with the rates paid in other lines of work.

The majority of technical graduates have been educated at their parents' expense, and when they leave school they feel that they do not want to be dependent any longer. They feel that they should earn at least enough to support themselves. This is hard to do at the rate of 10 cents an hour. It is true that this is more than the regular apprentice receives, but we must remember that the regular apprentice usually lives at home, or, if he does not, he receives help for a year or two. Then, again, the special apprentice is older, and his needs are greater. If he succeeds in supporting himself he does so at a considerable sacrifice. After the first year his wages are increased and the struggle for existence is not so hard. However, there are a great many who do not consider the experience worth the sacrifice which it entails.

After the term of apprenticeship has been served the idea is that, as previously stated, the man's theoretical and practical knowledge should be so blended that the combination will be of more value

than either of these attributes taken separately. Consequently, upon the completion of his special apprenticeship course the technical graduate should be paid at least a full-paid mechanic's wages. I believe that investigation will show that in a great many cases this is not done. When it is not done it indicates either that the man has not developed the properties which he was expected to develop by taking a special course, or else that the railroad is trying to retain him for less than his services are actually worth. If the former is the case, it were charity to inform him of the fact and advise him to seek other fields; if the latter is the case he is liable to seek other fields of his own accord or have others seek him.

If the apprentice has served four years he has reached the age where he wants a little more tangible remuneration than experience. He wants to feel that he is worth at least as much as another man who has served the same length of time as a regular apprentice. As a matter of fact, if he is not worth as much as a full-paid mechanic the railroad has failed to obtain the results it aimed at.

All through his special apprenticeship the man has been looking forward to obtaining a position of some kind upon the completion of his course. Unless he does receive such a position he is likely to go elsewhere. He can not be blamed for this, because for four years he has been neither one thing nor the other in the shop or on the road. He has been a sort of supernumerary. He begins to feel that he wants a position of some kind, no matter what it is, which he will know that if he is not filling some one else must; in fact, a vital place in the organization. As a matter of fact, he has spent four years with this as his aim. His intention has been to fit himself for an executive position on the railroad. The railroad company on its part has implied that it would be in need of him if he proved himself capable. Consequently, if, at the end of his special apprenticeship, he does not secure a vital position of some kind he is liable to seek work elsewhere. I recall to mind the case of a special apprentice whom I knew who had this complaint to make. Whenever he was asked what he was doing he could never give a satisfactory answer. He was neither apprentice nor mechanic nor boss. He did not fill any particular place. He was just working for the railroad. I believe that this is the principal cause of the special apprentice leaving railroad service. He has been expecting something which has not materialized and consequently he leaves the service.

The question arises, Why has not the expected position been forthcoming? Evidently it is due to one of two reasons. Either there is no place for him or else there are better men for the place.

Let us consider the last reason first, and see how well the special apprentice is qualified to hold a position as foreman.

In all probability he has not spent more than six months in any one department. This has been only long enough to give him a general idea of the running of the department. He has not been in it long enough to become thoroughly familiar with its workings. He must be rather an exceptional man in order that his superior will have enough confidence in his abilities to believe that he can run a department successfully when he has had but six months' experience in that kind of work.

Whenever a vacancy occurs there are usually some men in the ranks who are eligible to the position on account of their long experience in the department. As before stated, the superior officer is assuming considerable responsibility when he fills such a vacancy with a special apprentice rather than taking a man whose knowledge and experience in the work would make him the logical man for the place.

I believe this is one of the chief reasons why promotions are not forthcoming when the special apprentice expects them. Unless he has shown exceptional ability there is some hesitancy about promoting him to an executive position. In other words, he is not exactly the kind of a man he was expected to be at the end of four years.

The object of the special apprentice course is to make the man a specialist in railroad work. The indications are, however, that we have not gone far enough. His instruction has covered the whole mechanical field and at the end of his apprenticeship we have not the specialist we desire. Have we not been trying to do too much when we try to familiarize the man with half a dozen or more trades, the operation of car and locomotive shops and of engines on the road in four years' time? I believe that the result is that at the end of four years the man is still far from being a specialist. He has a general idea of these things, but he has not been in any one department long enough to become thoroughly familiar with it. The field he has been trying to cover is too large to be covered in the required time. I believe that better results would be obtained by not trying to do so much, but doing what is done more thoroughly, so that at the end of the four years the man would be a specialist. This could be done by offering different courses, each covering a separate field. By offering three courses the work would be subdivided enough that a man would become more of a specialist. These courses should be arranged to cover the following work:

First. Car building and repairs: The four years' work could be divided as follows: Six months in the freight-car shop on truck and body work; six months in the passenger-car shop; four months in the paint shop; four months in the wood mill; four months in the car blacksmith shop; six months in the car machine shop; four months in the yard; four months in the drawing-room; four months in the testroom, and the last six months at large.

Second. Locomotive building and repairs: The four years' work could be divided as follows: Ten months in the machine shop; six months on the floor; nine months in the boiler shop; nine months in the blacksmith shop; four months in the drawing-room; four months in the test-room, and the last six months at large.

Third: Locomotive operation: The four years' work could be divided as follows: Three months in the roundhouse as helper; two months in truck gang; one year as fireman; three months as boiler washer; six months with boilermaker; eight months with machinist; four months in drawing-room; four months in test-room, and six months at large.

The last six months of each course could be devoted to such work as the master mechanic saw fit. For instance, there might be one department in which he intended to place the man at the completion of his course. The last six months could very profitably be spent in that department.

By confining the special apprentice to one of these three lines of work he would doubtless be of more value at the end of his apprenticeship than he is under the present system. He would be a specialist in the particular line of work he has followed. There would not be the hesitancy there is at present about placing him in a position. He would surely be more competent under this system than he is under the present one. It is true he would not have had experience in all the departments, but at the same time he will not be entirely ignorant concerning them. If he has been at all observant he will have a general idea of the work in the other departments. At any rate, he will in all probability have a better idea of the work outside of the departments in which he has worked than will a master mechanic who has risen to his position from a mechanic.

The latter man will probably have, on account of his having risen from the ranks, one decided advantage over the special apprentice. He will understand his men better. He has worked by their sides and lived with them. He will appreciate their likes and dislikes and anticipate their ways of thinking and looking at things.

The better an officer is acquainted with the men under him the more successfully will he be able to deal with them. This is a fact which is lost sight of to a great extent in the special apprentice course.

It will enable him to look at all questions of shop management from two diametrically opposite points of view. He will not be nearly so liable, when the time comes, to give orders to do things which will antagonize the men in the shop if he knows and understands them thoroughly.

It is a notable fact that, as a rule, men who have come up from the ranks are more successful in the handling of men than the technical graduate. This, we believe, is due to their better knowledge of the persons with whom they have to deal.

The successful man is not so much the man who can do a great deal himself, but rather the one who can manage and direct the other men to concerted action and thus quickly attain the desired result.

So long as we insist on having a special apprentice system I believe that better results can be obtained by following the course as outlined above. To my mind, however, the special apprentice system is, at least, a poor one. The technical graduate is put in the shop and is given the best of opportunities to learn. He is given a great deal more attention than the ordinary apprentice. He is favored, and what is worse he expects it. On this account I am afraid that in a great many cases we turn out men who would have been a great deal better off if they had been given to understand that their advancement depended entirely on their own exertions. We favor them and turn out a hothouse plant which, when finally transplanted, can not stand the cold blast of competition. At the same time that the special apprentice is being favored, the general effect on the shop is not good. When the other men in the shop see the technical graduate rushed ahead they are not likely to be nearly as energetic as when they see that all men are being treated alike. The more you take away from a man his prospect for promotion, the less valuable he becomes. If every man in the service feels that his chance for promotion is as good as that of any one else you will have an organization which will do business and be free from discord.

Technical men are needed in railroad work and the need becomes greater every day.

In the February number of the American Engineer and Railroad Journal is a description of a plan by means of which the London & South-Western Railway hopes to obtain technically educated men from among its apprentices. This appears to be a step in the right direction. Time alone will tell how it will work out.

In the meantime the railroads are feeling the need of technical men, and the question is how to get them and keep them. If it is possible to hire these men without offering them any special inducement or making any promises I believe it would be the best way. This can frequently be done where a man is wanted for special work. He should be paid what he is worth, the same as any other man. By doing this the apprentices' and journeymen's ambitions are not stifled, and at the same time the technical man is put on his mettle, because any advancement which he receives will be due solely to his own efforts. If this cannot be done and it is absolutely necessary to have special apprentices, let us not attempt to do so much with one man. Let us make a specialist of him and a specialist who can be used.

In the meantime, let us not forget the regular apprentice. First of all, let us be more careful in the selection of these boys. Too often there is practically no attention paid to the boy himself. He is often the boy who could not get along at school, or who would not go there, or probably his parents have not been able to manage him at all. As a last resort he is sent to the shop to learn a trade, not because of any ability he has shown or is likely to show, but it may be he has some influential friend who has spoken for him, or probably his father is working for the railroad and he is employed because he is the son of his father. This turns the shop into a reform school.

It may be that the apprentices' wages are not high enough to draw a desirable class of boys in all communities. If such is the case, it would pay to increase them and then insist upon a certain standard.

After we have done this let us make the regular apprentice feel that we are interested in his welfare. Let us encourage him to improve himself technically. Let us help him in every way we can and make him feel that he stands in line of promotion. By doing this I believe we will be able to obtain just as good men in the future as we have in the past, and the technical graduate will be at the front with the rest if he proves himself worthy.

LOCOMOTIVE FRONT ENDS.

COMMITTEE—H. H. VAUGHAN, F. H. CLARK, R. QUAYLE, A. W. GIBBS, W. F. M. GOSS, G. M. BASFORD.

Your committee on locomotive front ends begs to report that, at a meeting held soon after its appointment, and after a full discussion, a subcommittee was formed consisting of Messrs. W. F. M. Goss, G. M. Basford and H. H. Vaughan, to draw up a schedule of the tests which are needed to more perfectly define the action of the front end. This subcommittee recommended that work proceed in accord with the following outline:

Series No. 1. This series of tests is to include experiments on a large engine having a front end not less than 75 ins. in diameter, the tests being designed to confirm or correct the deduction made from the results already obtained on an engine having a 54-in. front end in the tests conducted by the AMERICAN ENGINEER, the proposed tests to be carried only so far as may be necessary to indicate the proper factor to be used in comparing large and small front ends. This series of tests to include the following variables:

Straight and Taper Stacks.

Stack diameter, 11¾ ins., 15¾ ins., 19¾ ins., 23¾ ins.

Stack heights, 16½ ins., 26½ ins., 36½ ins., 46½ ins., 56½ ins.

Nozzle heights, 20 ins. and 10 ins. below center, on center and 20 ins. above center.

All tests to be made in triplicate. It is thought unnecessary to run tests at varying cut-offs and speeds except for check runs, as the influence of these factors was decided in the previous tests. These tests will include all that is necessary to determine completely the relation between stacks and nozzles for any diameter of front ends. It is estimated that they will occupy twenty days.

Series No. 2. This series to be made in connection with a front end arranged with an inside false top slightly above the top row of flues, the stack extending from the inside false top. It is thought probable that the results of these tests will agree closely with those obtained from the previous series when comparisons are based on measurements defining nozzle position as measured from the top of the stack. In so far as this may prove true, the test will simply be confirmatory of previous results. To make this test it will be necessary to fit a false inside top to the smokearch and obtain new bases, two in number, to apply the experimental stack to the false top. The series to include the following variables:

Stack diameters, 11¾ ins., 15¾ ins., 19¾ ins., 23¾ ins.

Stack heights, 16½ ins., 26½ ins., 36½ ins., 46½ ins., 56½ ins.

Nozzle position, 20 ins. and 10 ins. below center, on center and 10 ins. and 20 ins. above center.

It is estimated that this series will occupy ten days.

Series No. 3. This series to be in connection with a front end fitted with inside taper stacks without false top and and smokebox. It is thought to be unnecessary to experiment on straight stacks, as these have already been shown to be inferior to taper. The series to include the following variables:

Stack diameters, same as for Series No. 2.

Three different amounts of projection of stack into the front end.

Two different heights of outside stack.

Nozzle positions, 20 ins. and 10 ins. below center and on center.

The experimental stacks for this series to be made of sheet iron. If as the tests of this series proceed it appears that the results obtained are directly comparable with those obtained from Series No. 2, but simply slightly inferior on account of different action through the absence of the false top, this series will be abridged. It is estimated that this series will occupy six days.

Series No. 4. This series to include the use of a single draft pipe. The series to include the following variables:

Draft pipes diameter, 9 ins., 13 ins., 17 ins., 21 ins.

Draft pipes of each diameter to be tested in two different lengths.

Nozzle position, 20 ins. and 10 ins. below center, on center and 10 ins. above center.

Stack diameters, 11¾ ins., 15¾ ins., 19¾ ins., 23¾ ins.

Stack heights, 16 ins., 26 ins. and 46 ins.

It is assumed that it will not be necessary to experiment with both lengths of draft pipe in connection with all nozzle positions, the purpose being to include draft pipes of widely varying lengths and very low nozzle positions. Experimental draft pipes necessary for this series will be made of sheet iron. It is estimated that this series will occupy sixteen days.

In presenting this outline the subcommittee expressed the hope that members of the committee would be able to supply such portions of the equipment as the sheet iron inside stack, draft pipes, etc., so as to make the expense to the association as small as possible. They also give emphasis to the fact that if the tests as outlined can be carried out, the results will definitely settle the relation between stack and nozzle for any height of stack on any size of front ends, value of the draft pipes and their proportions for best results, and the value of inside stacks both with and without false tops. It is evident also that if the full purpose of the subcommittee can be carried out, the whole front end of any diameter may be designed by reference to definite formulæ, which will insure maximum performance.

Having received the report of the subcommittee, Mr. Vaughan, as chairman, acting in behalf of the undersigned, your full committee addressed the following letter to the executive committee of the American Railway Master Mechanics' Association:

"The committee appointed to assist the *American Engineer and Railroad Journal* in continuing tests inaugurated by them on the subject of locomotive front ends begs to advise you that a decision has been reached as to the further series of tests which it is desirable to carry out in connection with this subject at Purdue University, and that these tests and the expense of conducting same will be as follows:

"Series 1. Test on a large engine to complete the determination of the relation between stacks and nozzles with reference to which complete information has been obtained on an engine having a front end of 54 ins. in diameter in the tests that are already completed. The cost of this series will be as follows:

Equipment	$200.00
Testing expenses	500.00
	$700.00

A portion of these expenses may be avoided if, as it is hoped, certain railroad companies will contribute a portion of the equipment.

"Series 2. Test to determine the proper proportion of stack to be used on front end having inside stack with false top. The cost of this series will be as follows:

Equipment	$100.00
Testing expenses	250.00
	$350.00

"Series 3. Test to determine correct proportion of stacks for front ends having inside stacks without false tops. The cost of this series will be as follows:

Equipment	$ 50.00
Testing expenses	150.00
	$200.00

"Series 4. Test to determine relation of stack and nozzle with single draft pipes. It has been decided not to experiment with double draft pipes as it is considered that the single draft pipes will answer all practical purposes and will avoid a great deal of expense, the double draft pipe problem being exceedingly complicated. The cost of this series will be as follows:

Equipment	$100.00
Testing expenses	500.00
	$600.00

"In addition to the above expenses it will be necessary to make an initial expenditure to cover the expense of changing the engine, getting the large engine into place and moving the engine at present on the testing plant, changing roof of the building slightly and other miscellaneous items in connection with this change, not including freight, as it is hoped that this can be arranged for with the railroad companies transporting the test engine. This expense will amount to $200.

"It will also be necessary to adapt the present equipment, indicator, draft gauges, etc., to the test engine, also spend a certain amount in fitting up the present experimental stacks, obtaining a new set of experimental nozzles, etc., which expense will amount to $100.

"Recapitulating the total cost of the tests which the committee desires to carry out will be as follows:

Change of locomotives	$ 200.00
Engine equipment	100.00
Test Series No. 1	700.00
Test Series No. 2	350.00
Test Series No. 3	200.00
Test Series No. 4	600.00
	$2,150.00

"In accordance with the committee's instructions we would apply to you for the necessary funds to carry out this important work. I would ask that immediate action be taken on this question as it is exceedingly important that we get to work at once if the work is to be completed during the present year. I am also pleased to be able to add that the North-Western Railway, through the kindness of Mr. Quayle, has offered to contribute their quota of expenses in furnishing material, so that I have no doubt that we can reduce the total expenditure below the sum mentioned above.

"It should be mentioned that in the above estimate, no amount is allowed for the service of Professor Goss, who will direct this work, and it is hoped that the series may be completed under this amount as it is not intended to run any series of tests further than is necessary to determine the best form of stack to be used; allowance has, as we consider, been made for difficulties in discovering the best proportions which may occur during the tests.

"H. H. VAUGHAN, Chairman."

In reply to this communication the secretary made the following statement with reference to the action of the executive committee:

"Referring again to yours of September 11, addressed to the executive committee of the Master Mechanics' Association, regarding the funds necessary to continue the tests on 'Locomotive Front Ends,' I presented this matter to the executive committee at a meeting held in New York City on November 23. The committee did not authorize this expenditure, inasmuch as the constitution provides:

"'All expenditures for special purposes shall only be made by appropriation acted upon by the association at a regular meeting.'

"JOS. W. TAYLOR, Secretary."

In view of this decision your committee felt that it was impossible to take any further steps in the matter, and that its only course was to report to the association the status of affairs and make a formal request that sufficient money be appropriated to enable the tests to be carried out. This we now formally and respectfully do.

(To be continued.)

The New York Continental-Jewell Filtration Company has recently closed, through its Chicago office, contracts with the Waterloo Water Company for a filter of 500,000 gallons daily capacity; with the Chicago & Eastern Illinois Railroad for a filter of 500,000 gallons daily capacity, to be installed at Villa Grove, Ill., and with the Southern Pacific Company for a filter plant of 400,000 gallons daily capacity, to be installed at Yuma, Ariz.

MASTER CAR BUILDERS' ASSOCIATION.

Thirty-eighth Annual Convention.

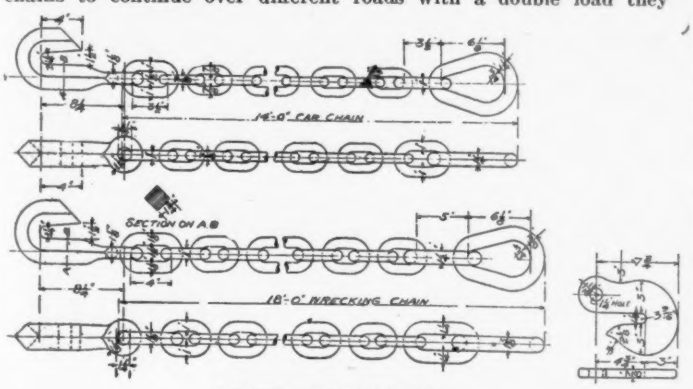
SARATOGA, N. Y., JUNE 22 TO 24.

ABSTRACTS OF REPORTS.

COUPLING CHAINS.

COMMITTEE—R. P. C. SANDERSON, R. L. KLEIN, R. B. RASBRIDGE, JAMES MACBETH.

Your committee would recommend these chains for recommended practice of the association, with the idea that the association could set a fair value on such chains according to the market price which might prevail from year to year, and when it is desired for such chains to continue over different roads with a double load they



CHAINS RECOMMENDED.

could be continued to destination at the M. C. B. cost, and in case the chains are returned same cost figure could be used in counter-billing without reference to the identity of the individual chain, so long as the chains conform to the M. C. B. proposed recommended practice.

STAKE POCKETS.

COMMITTEE—J. S. CHAMBERS, W. E. FOWLER, J. E. KEEGAN, R. P. C. SANDERSON, M. DUNN.

The conclusions resulting from the votes and recommendations of the committee are:

1. That a standard stake pocket be adopted.

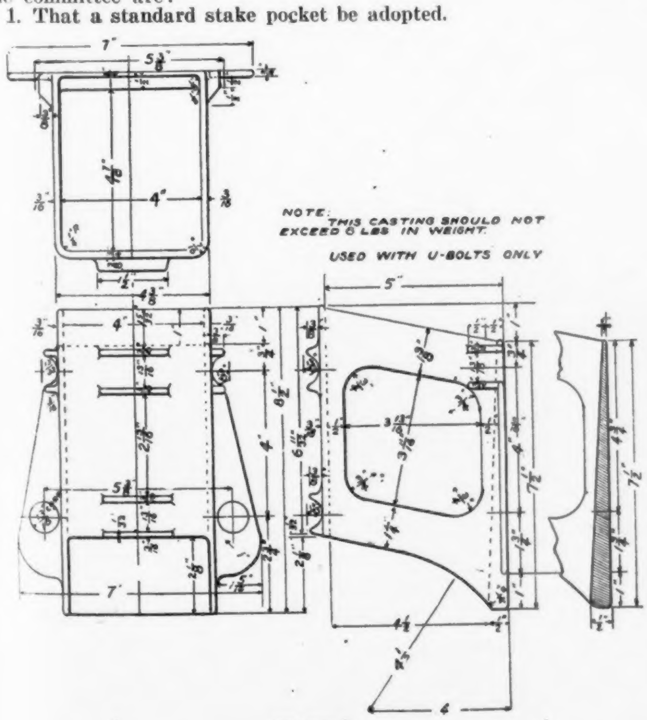


PLATE 1.

2. That inside dimensions of same be 4 ins. wide, 5 ins. deep.
3. That a tapering wedge be used, as shown on plates Nos. 1 and 2.
4. That the method of securing stake pockets to both wooden and steel construction be by U-bolts, held by nuts or riveted.
5. That malleable iron be used as standard construction.
6. On a 40-foot car that *not less* than ten pockets be applied, in the following manner: Measuring from center of car, pockets to be applied equal distance from each side of center.

On a 35-ft. car *not less* than nine pockets to be applied; first pocket in center of car and balance of pockets spaced equal distance.

On 32-ft. cars *not less* than eight pockets; measuring from center of car, pockets to be spaced equal distance from center of car.

If any roads desire that pockets be placed closer at ends of car and wider apart at center, this can be done.

CAST-IRON WHEELS.

COMMITTEE—WM. GARSTANG, G. R. HENDERSON, W. H. LEWIS, E. D. NELSON, A. KEARNEY, H. J. SMALL.

Your committee, instructed to confer with the Cast-Iron Wheel Manufacturers and jointly to submit designs and specifications for cast-iron wheels for cars of 60,000, 80,000 and 100,000 pounds capacity, reports as follows:

The importance of the work and the desire to submit for adoption a report that the members of this association could feel assured had received the fullest and most careful consideration by the joint committee, has been the aim throughout the year. Very shortly after the 1903 convention the first meeting of these committees was held, and throughout the year there have been meetings, correspondence and tests carried on with the view of confirming in every way possible the wisdom and accuracy of each recommendation; we therefore present this report with great confidence.

The designs of wheels are shown by complete drawings 1, 2, 3 and 4. Drawing No. 1 showing a 600-lb. wheel recommended for cars of 60,000 lbs. capacity, drawing No. 2 showing a 650-lb. wheel recommended for cars of 80,000 lbs. capacity, drawing No. 3 showing a 700-lb. wheel recommended for cars of 100,000 lbs. capacity, and drawing No. 4 showing a composite drawing of the three wheels for reference purposes.

SPECIFICATIONS.

For 33-in. Cast-Iron Wheels Weighing 600, 650 and 700 Pounds. For Cars of 60,000, 80,000 and 100,000 Pounds Capacity.

1. Chills must have the same inside profile as shown by M. C. B. drawings of wheel tread. The inside diameter of chill must be the M. C. B. standard of 33½ ins., measured at a point 2⅝ ins. from outside of tread of wheel.

2. Wheels of the same normal diameter must not vary more than one-fourth (¼) of an in. above or below the mean size measured on the circumference, and the same wheel must not vary more than one-sixteenth (1-16) of an in. in diameter. The body of the wheel must be smooth and free from slag, shrinkage or blowholes. The tread must be free from deep and irregular wrinkles, slag, chill cracks and sweat or beads in throat, and swollen rims.

3. The wheels must show clean gray iron in the plates, except at chaplets, where mottling to not more than one-half (½) in. from same will be permitted. The depth of pure white iron must not exceed one (1) in. nor be less than one-half (½) in. in the middle of the tread, and shall not be less than three-eighths (⅜) in. in the throat, for wheels weighing six hundred (600) lbs. It

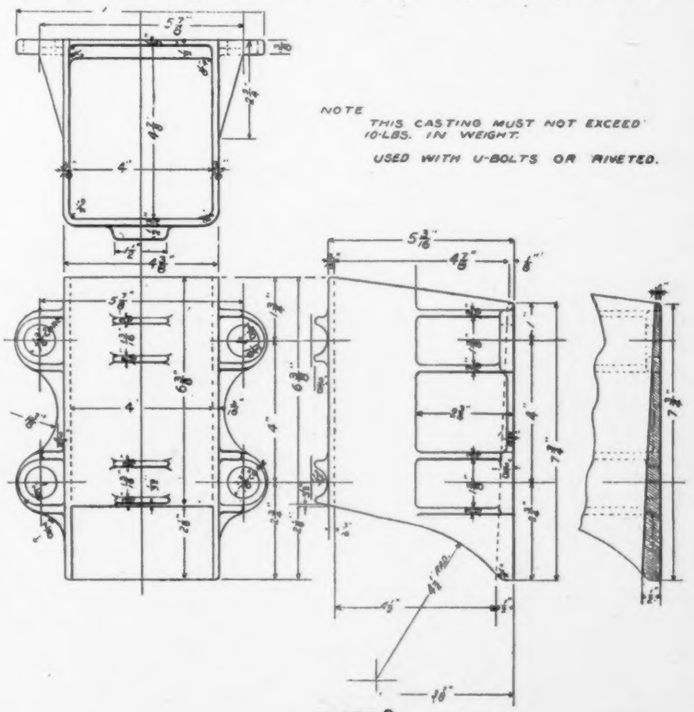


PLATE 2.

shall not exceed one (1) in. in the middle of the tread nor be less than seven-sixteenths (7-16) in. in the throat for wheels weighing six hundred and fifty (650) lbs., and shall not exceed one (1) in. in the tread or be less than one-half (½) in. in the throat for wheels weighing seven hundred (700) lbs. The depth of white iron shall not vary more than one-fourth (¼) of an in. around the tread on the rail line in the same wheel.

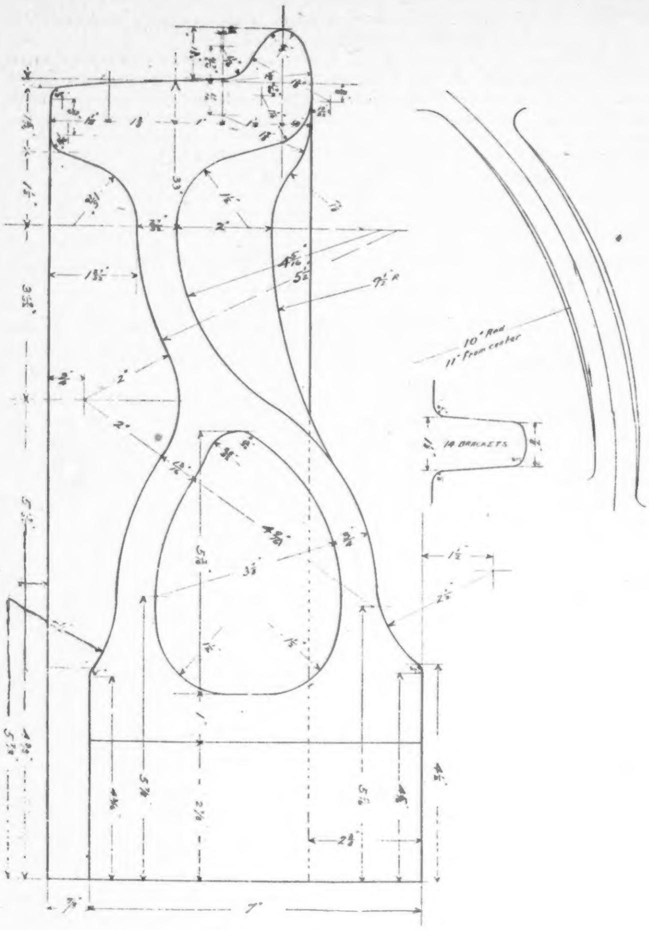


PLATE 1.—33 IN. 600-LB. CAST IRON WHEEL FOR 60,000-LB. CARS.

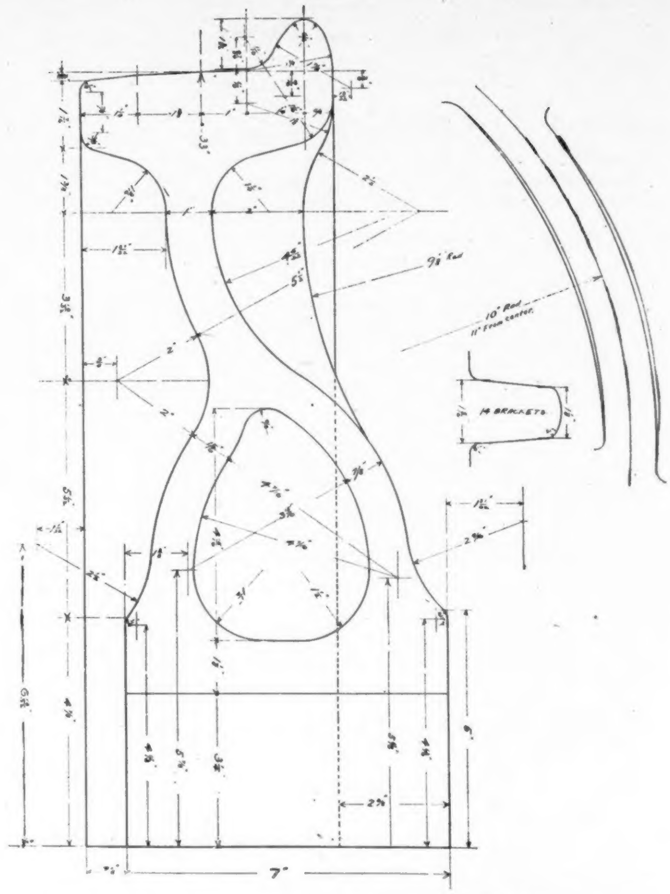


PLATE 2.—33 IN. 650-LB. CAST IRON WHEEL FOR 80,000-LB. CARS.

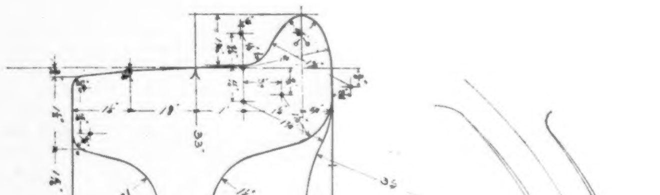


PLATE 3.—33 IN. 700-LB. CAST IRON WHEEL FOR 100,000-LB. CARS.

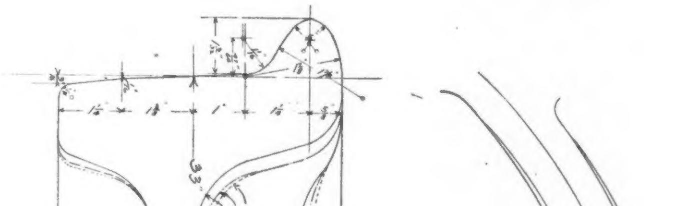


PLATE 4.—PROPOSED 33 IN. 600, 650 AND 700-LB. CAST IRON WHEEL.

4. For each hundred wheels which pass inspection and are ready for shipment, two representative wheels shall be taken at random, one of which shall be subjected to the following tests:

The wheel shall be placed flange downward on an anvil block, weighing not less than seventeen hundred (1,700) lbs., set on rubble masonry at least two (2) feet deep, and having three supports not more than five (5) ins. wide to rest upon. It shall be struck centrally on the hub by a weight of two hundred (200) lbs. For six hundred (600) lb. wheels, ten (10) blows falling from a height of nine (9) ft. For six hundred and fifty (650) lb. wheels, twelve (12) blows falling from a height of ten (10) feet, and for seven hundred (700) lb. wheels, twelve (12) blows falling from a height of twelve (12) feet. Should the test wheel stand the given number of blows without breaking in two or more pieces, the inspector will then subject the other wheel to the following test:

The wheel must be laid flange down in the sand and a channel way one and one-half (1½) ins. wide and four (4) ins. deep must be molded with green sand around the wheel. The clean tread of the wheel must form one side of the channel way, and the clean flange must form as much of the bottom as its width will cover. The channel way must then be filled to the top with molten cast-iron, which must be hot enough, when poured, so that the ring which is formed when metal is cold shall be solid or free from wrinkles or layers. The time when the pouring ceases must be noted, and two minutes later an examination of the wheel must be made. If the wheel is found broken in pieces, or if any crack in the plate extends through or into the tread, the one hundred wheels represented by the tests will be rejected.

5. In case of the drop tests, should the test wheel break in two or more pieces with less than the required number of blows, then the second wheel shall be taken from the same lot and similarly tested. If the second wheel stands the test it shall be optional with the inspector whether he shall test the third wheel or not; if he does not do so, or if he does, and the third wheel stands the test, the hundred wheels shall be accepted as filling the requirements of the drop test.

6. The lower face of the weight of two hundred (200) lbs. shall be eight (8) ins. in diameter, and have a flat face.

7. Wheels shall not vary from the specified weight more than 2 per cent.

8. The thickness of the flange shall be regulated by the maximum and minimum flange thickness gauges adopted by the M. C. B. Association.

9. All wheels must be numbered consecutively in accordance with instructions from the railroad company purchasing them, and shall have the number, the normal weight of the wheel, also the day, month and year when made plainly formed on the inside plate in casting, and no two wheels shall have the same number. All wheels shall also have the name of the maker and place of manufacture plainly formed on the outside plate in casting.

10. Individual wheels will not be accepted which (1) do not conform to standard design and measurements; (2) are under or over weight; (3) have physical defects described in section 2. Any lot of one hundred wheels submitted to test will not be accepted (1) if wheels broken do not meet the prescribed drop test; (2) if the wheel tested does not stand the thermal tests; (3) if the conditions prescribed in section 3 are not complied with.

11. All wheels must be taped with M. C. B. standard design of wheel circumference tape having numbers 1, 2, 3, 4, 5 stamped one-eighth (⅛) in. apart, the figure three (3) to represent the normal diameter, 103.67 ins. circumference, the figure one (1) the smallest diameter and the figure five (5) the largest diameter.

AIR-BRAKE HOSE SPECIFICATIONS.

COMMITTEE—L. G. PARISH, T. S. LLOYD, J. MILLIKEN, F. H. SCHEFFER, H. SWOYER.

The original specifications for air-brake hose provided for a woven hose with seamless tubing. The present specifications do not cover this feature; therefore your committee has taken this into consideration in making up proposed specifications, as it is thought advisable to allow this form of air-brake hose to be used if it will meet the tests.

In view of the fact that air-brake hose made to M. C. B. specifications by the several manufacturers do not give the same length of service, a number of roads have found it advisable to keep service records in order to determine the life of hose made by the different manufacturers. Two of the most notable points brought out in these records are the rapid falling off in the friction between the layers of duck after a comparatively short life, and damage at the nipple end of the hose due to separating cars without uncoupling the hose by hand.

It is found that nearly all of the hose tested stand the bursting pressure satisfactorily after being in service for some length of time, showing that the present bursting test, calling for 500 lbs. pressure for 10 minutes, is higher than necessary.

This service record to a large extent should determine whether the present specifications are correct. The study of these records has developed the fact that it is not always the M. C. B. specification hose that gives the longest life. It is a well-known fact that at least 80 per cent. of air-brake hose fail on account of unfair usage for which the manufacturer is not responsible, in view of which your committee has recommended a specification which should give as long life as the present M. C. B. standard. In view of the fact that it can be manufactured for at least 7 cts. per foot less than the present M. B. standard, the saving to the railroads should be very large.

There has been much said and written on this subject, showing conclusively that everybody is alive to the fact that the life of an air-brake hose is governed largely by the treatment it receives in service. The most destructive practice we have to contend with is pulling cars apart without uncoupling hose by hand. We find that the responsibility in some cases lies with the motive-power department and in other cases with the transportation department. If the hose in large terminal yards were cut by the inspectors, this damage would be largely decreased. If the responsibility is divided between the yard men and inspectors, there is no way of stopping the abuse on account of the responsibility being divided. Attempts have been made to correct this evil, but without much success. The principal fault lies in the fact that great pressure is brought to bear on the yard men and inspectors to switch trains as quickly as possible, the cost per car handled through the yard being used to a great extent to measure the efficiency of the men. Your committee would recommend that the responsibility for parting air-brake hose by hand be placed entirely on the motive-power department in terminal yards, and that united action be taken by all railroads to put a stop to the present abuse.

The location of angle cock and train pipe has not been given the proper attention. At the present time M. C. B. recommended practice specifies that train pipe be located 13 ins. from the center line of car, and that it be turned to an angle of 30 degs. Your committee would call attention to the importance of this recommendation and would recommend that it be made M. C. B. standard. At the present time these features are not being given proper attention. The improper location of train pipe and angle cock brings about a condition which is fully as bad as pulling the cars apart without uncoupling hose by hand. The standard 22-in. hose is of sufficient length if the angle cock and train pipe are located as per M. C. B. recommended practice. If, however, the train pipe is located over 13 ins. away from center line of car and the angle cock vertical, the distance is greatly increased, and when the slack is taken out of the couplers the hose is ruptured on account of excessive strain. This is a condition which should receive immediate attention.

On account of excessive damage to hose at the nipple end, your committee has considered it best to increase the inside diameter ⅛ in. This will not increase the cost of manufacture to any great extent, and the increased size will not bring the cost above hose manufactured with enlarged ends. This will give a little larger diameter at the nipple end, where it is greatly needed.

Particular attention is also called to the damage which is done to the inner tube by improper mounting of hose. Air machines for mounting hose, if not properly made, do great damage to the inner tube. It is also very important that the hose be so applied to cars that the heads will register properly when they are coupled. If it is necessary to twist them in order to couple, the danger from burst hose is greatly increased on account of the liability of hose bursting when the slack is taken up on the train.

There are a great many other points which might be touched on in connection with the abuse of air-brake hose, but your committee does not feel it necessary to call attention to these minor details, as everyone should be thoroughly familiar with them. It requires close attention on the part of shop men and inspectors to see that hose receives proper treatment.

Specifications and test for air-brake hose were adopted as recommended practices, advanced to standard in 1903. These specifications are herewith modified as follows:

(1) All air-brake hose must be soft and pliable, and not less than two-ply nor more than four-ply. They must be made of rubber and cotton fabric, each of the best of its kind made for the purpose; no rubber substitutes or short-fiber cotton to be used.

(2) The tube must be hand-made, composed of three calendars of rubber. It must be free from holes and imperfections, and in joining must be so firmly united to the cotton fabric that it cannot be separated without breaking or splitting the tube. The tube must be of such composition and so cured as to successfully meet the requirements of the stretching test given below. The tube to be not less than 3-32 in. thick at any point.

(3) The canvas or woven fabric used as wrapping for the hose to be made of long-fiber cotton, loosely woven, and to be from 38 to 40 ins. wide, and to weigh not less than 20 and 22 oz. per yard, respectively. The wrapping must be frictioned on both sides, and must have, in addition, a distinct coating or layer of gum between each ply of wrapping. The canvas wrapping must be applied on the bias. Woven or braided covering should be so loose in texture that the rubber on either side will be firmly united.

(4) The cover must be of the same quality of gum as the tube, and must not be less than 1-16 in. thick.

(5) Hose is to be furnished in 22-in. lengths. Variations exceeding ¼ in. in length will not be permitted. Rubber caps not less than 1-16 in. nor more than ⅛ in. must be vulcanized on each end.

(6) Hose must be furnished in 22-in. lengths. Variations exceeding ¼ in. above or below this will not be accepted. The inside diameter must not be less than 1⅜ ins. nor more than 1 7-16 ins., nor must the outside diameter exceed 2 ins. Hose must be smooth and regular in size throughout its entire length, except at a point 2½ ins. from either end, where the inside calendar of rubber may be increased 1-16 in. for a distance of ¼ in. toward either end and then tapering to the regular diameter.

(7) Each length of hose must have vulcanized to it a badge of white or red rubber, as shown. On the top of the badge the name of the purchaser, on the bottom the maker's name, on the left-hand end the month and the year of manufacture, and on the right-hand end the serial number and the letters "M. C. B. Sta." The letters and figures must be clear and distinct, not less than 3-16 in. in height, and stand in relief not less than 1-32 in., so that they can be removed by cutting without endangering the cover. Each lot of 200 or less must bear the manufacturer's serial number, commencing at 1 on the first of the year and continuing consecutively until the end of the year.

For each lot of 200, one extra hose must be furnished free of cost.

(8) Test hose will be subject to the following tests:

BURSTING TEST.

The hose selected for test will have a section 5 ins. long cut from one end, and the remaining 17 ins. will then be subjected to a hydraulic pressure of 100 lbs. per square inch, under which pressure it must not expand more than ¼ in. nor develop any small leaks or defects. The section will then be subjected to a hydraulic pressure of 400 lbs. per square inch for 10 minutes, without bursting.

FRICTION TEST.

A section 1 in. long will be taken from the 5-in. piece previously cut off, and the quality of the friction determined by suspending a 20-lb. weight to the separated end, the force being applied radially, and the time of unwinding must not exceed 8 ins. in 10 minutes.

STRETCHING TEST.

Another section 1 in. long will be cut from the balance of the 5-in. piece, and the rubber tube or lining will be separated from the ply and cut at the lap. Marks 2 ins. apart will be placed on this section, and then the section will be quickly stretched until the marks are 8 ins. apart, and immediately released. The section will then be re-marked as at first and stretched to 8 ins., and will remain so stretched 10 minutes. It will then be released, and 10 minutes later the distance between the marks last applied will be measured. In no case must the test piece break or show a permanent elongation of more than ¼ in. between the marks last applied. Small strips taken from the cover or friction will be subjected to the same tests.

(9) If the test hose fails to meet the required tests, the lot from which it was taken may be rejected without further examination and returned to the manufacturer, who shall pay the freight charges in both directions. If the test hose is satisfactory, the entire lot will be examined, and those complying with the specifications will be accepted.

WHAT IS THE BEST PREVENTIVE OF RUST ON STEEL CARS?

COMMITTEE—H. S. HAYWARD, J. S. LENTZ, W. G. GORBELL, T. H. RUSSUM, C. E. FULLER.

1. *For New Cars.*—(*a*) The steel should be thoroughly cleaned of all rust and furnace scale before the car is assembled. (*b*) All joints before assembling should be thoroughly coated with coal tar. (*c*) After car is assembled all grease should be thoroughly removed from the steel and same given a good coat of carbon or graphite paint on the outside and underneath, and the inside a heavy coat of crude petroleum, coal tar applied hot, or some similar substance. (*d*) The outside to be given a second coat of graphite or carbon paint, as may be desired.

2. *For Old Cars.*—(*a*) All scale and rust should be removed wherever it appears on the car, by steel brushes or scrapers, and in the case of the inside of the car by any of the above methods or by the use of pneumatic hammers or mauls. (*b*) After all scale and rust have been removed the car should be thoroughly cleaned with steel scrapers or wire brushes and blown out with air, in order to present a clean surface for the paint. (*c*) The methods of painting recommended for new cars should be followed out in the case of old cars, after a clean surface is obtained.

3. As some of the most prolific causes of deterioration of steel cars are the loading of same with hot billets, the use of mauls, bars, etc., on the outside to assist in the unloading of cars, and the allowing of cars loaded with soft coal to stand a long time with the load on same, it is recommended that steps be taken to do away with these practices as much as possible.

Your committee believes that if the above recommendations are followed out, and if care is taken to repaint the outside of and underneath cars at least every eighteen months or two years, coating the inside with crude petroleum or coal tar about once a year, excellent results will be obtained.

SUBJECTS.

COMMITTEE—J. T. CHAMBERLAIN, C. A. SCHROYER, J. S. LENTZ.

FOR COMMITTEE WORK DURING 1904-'05.

1. The use of steel in passenger car construction.

Your committee is informed that an individual paper will be presented at the convention on the above subject, and believes it is of sufficient importance to require further investigation by a committee of the association.

2. Specifications and tests for bolsters, brake beams, etc.

This association has just installed at Purdue University, Lafayette, Ind., a drop-test machine for M. C. B. couplers. The machine is available for testing other parts of cars, and it is suggested that we make use of our property to study the question of specification and tests for bolsters, brake beams and such other car details as require tests of that character to determine their strength and efficiency.

3. Grain doors.

The Central Traffic Association has suggested the adoption of a suitable grain door to meet the requirements of large-capacity cars. Your committee believes the subject is worthy of investigation.

4. Flexible car trucks vs. rigid trucks.

To consider what flange wear of wheels, if any, is reduced over rigid trucks, and what difference, if any, exists as to absorption of power.

5. Recent designs of heavy trolley-car trucks.

To see if the prevailing combination of iron and wood trucks in passenger-car service cannot be superseded by a lighter, stronger and cheaper all-steel truck.

6. Axles.

To investigate the practice of some roads of turning car axles so that there is a shoulder behind the wheel hub, which hub is faced and wheels mounted to 1-16 in. of this shoulder, it being claimed derailment will not attend a loose wheel when this practice is followed.

(*To be continued.*)

EXHIBITS AT THE CONVENTIONS.

MASTER MECHANICS' AND MASTER CAR BUILDERS' ASSOCIATIONS.

Acme Supply Co., Chicago, Ill.
Adams & Westlake Company, The, Chicago, Ill.
American Balance Valve Company, Jersey Shore, Pa.
American Brake Shoe and Foundry Company, Mahwah, N. J.
American Locomotive Equipment Company, Chicago, Ill.
American Steam Gauge and Valve Company, Boston, Mass.
Aurora Metal Company, Aurora, Ill.
Baltimore Railway Specialty Company, Baltimore, Md.
Bettendorf Axle Company, Chicago, Ill.
Bowser, S. F., & Co., Fort Wayne, Ind.
Buckeye Steel Castings Company, Columbus, Ohio.
Case Manufacturing Company, Columbus, Ohio.
Chicago Car Heating Company, Chicago, Ill.
Chicago Pneumatic Tool Company, New York.
Cleveland Car Specialty Company, Cleveland, Ohio.
Columbus Steel Rolling Shutter Co., Columbus, Ohio.
Commonwealth Steel Company, St. Louis, Mo.
Consolidated Car Heating Company, Albany, N. Y.
Consolidated Railway Electric Lighting and Equipment Company, New York.
Corrington Air Brake Company, Matteawan, N. Y.
Crandall Packing Co., Palmyra, N. Y.
Crane Company, Chicago, Ill.
Crosby Steam Gauge and Valve Company, Boston, Mass.
Damascus Brake Beam Company, St. Louis, Mo.
Davis Pressed Steel Company, Wilmington, Del.
Dickinson, Paul, Chicago, Ill.
Dixon Crucible Co., Jersey City, N. J.
Drouve G., Co., Bridgeport, Conn.
Duner & Co., Chicago.
Fabrikoid Company, Newburgh, N. Y.
Fairbanks Company, New York.
Fairbanks, Morse & Co., Chicago, Ill.
Farlow Draft Gear Company, Baltimore, Md.
Federal Company, Chicago, Ill.
Federal Manufacturing Company, Cleveland, Ohio.
Flannery Bolt Company, Pittsburgh, Pa.
Forsyth Bros. Company, Chicago, Ill.
Franklin Manufacturing Company, Franklin, Pa.
Franklin Railway Supply Company, Franklin, Pa.
Garlock Packing Company, New York.
Gisholt Machine Company, Madison, Wis.
Gold Car Heating and Lighting Company, New York.
Gould Coupler Company, Depew, N. Y.
Hammett, M. C., Troy, N. Y.
Handy Car Equipment Company, Chicago, Ill.
Hayden Manufacturing Company, N. L., Columbus, Ohio.
Holland Company, Chicago, Ill.
Homestead Valve Manufacturing Company, Homestead, Pa.
Illinois Malleable Iron Company, Chicago, Ill.
Johns-Manville Company, New York.
Kennicott Water Softener Company, Chicago, Ill.
Keystone Drop Forge Works, Chester, Pa.
Kindl Car Truck Company, Chicago, Ill.
Kinnear Manufacturing Co., Columbus, Ohio.
Lodge & Shipley Machine Tool Company, Cincinnati, Ohio.
Manning, Maxwell & Moore, New York.
Manufacturers' Railway Supply Company, Chicago, Ill.
Martin Car Heating Company, Chicago, Ill.
Mason Regulator Company, Boston, Mass.
McConway & Torley Company, Pittsburgh, Pa.
McCord & Co., Chicago, Ill.
Merritt & Co., Philadelphia, Pa.
Metal Plated Car and Lumber Company, New York.
Michigan Lubricator Company, Detroit, Mich.
Midland Railway Supply Company, Chicago, Ill.
Modern Tool Company, Erie, Pa.
Moran Flexible Joint Company, Louisville, Ky.
National Car Coupler Company, Chicago, Ill.
National Lock Washer Company, Newark, N. J.
National Malleable Iron Company, Cleveland, Ohio.
Norton, A. C., Boston, Mass.
Norton Emery Wheel Company, Worcester, Mass.
Pearson Jack Company, Boston, Mass.
Peckham Manufacturing Company, New York.
Pierce, Charles F., New York.
Pittsburgh Spring and Steel Company, Pittsburgh, Pa.
Pyle National Electric Headlight Company, Chicago, Ill.
Rand Drill Company, New York.
Safety Car Heating & Lighting Co., New York.
Schoen Steel Wheel Company, Pittsburgh, Pa.
Simplex Railway Appliance Company, Hammond, Ind.
Standard Car Truck Company, Chicago, Ill.
Standard Coupler Company, New York.
Star Brass Manufacturing Company, Boston, Mass.
Sterlingworth Railway Supply Company, Philadelphia, Pa.
Symington Company, T. H., Baltimore, Md.
Underwood & Co., H. B., Philadelphia, Pa.
United States Metal and Manufacturing Company, New York.
Waugh Draft Gear Company, Chicago, Ill.
Walworth Manufacturing Co., Boston, Mass.
Western Railway Equipment Company, St. Louis, Mo.
Western Tube Company, Kewanee, Ill.
Wells, F. L., Chicago, Ill.
Westinghouse Air Brake Company, Pittsburgh, Pa.
Wheel Truing Brake Shoe Company, Detroit, Mich.
Wood, G. S., Chicago, Ill.